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## PRINTING PRESSES AT THE CENTENNIAL.

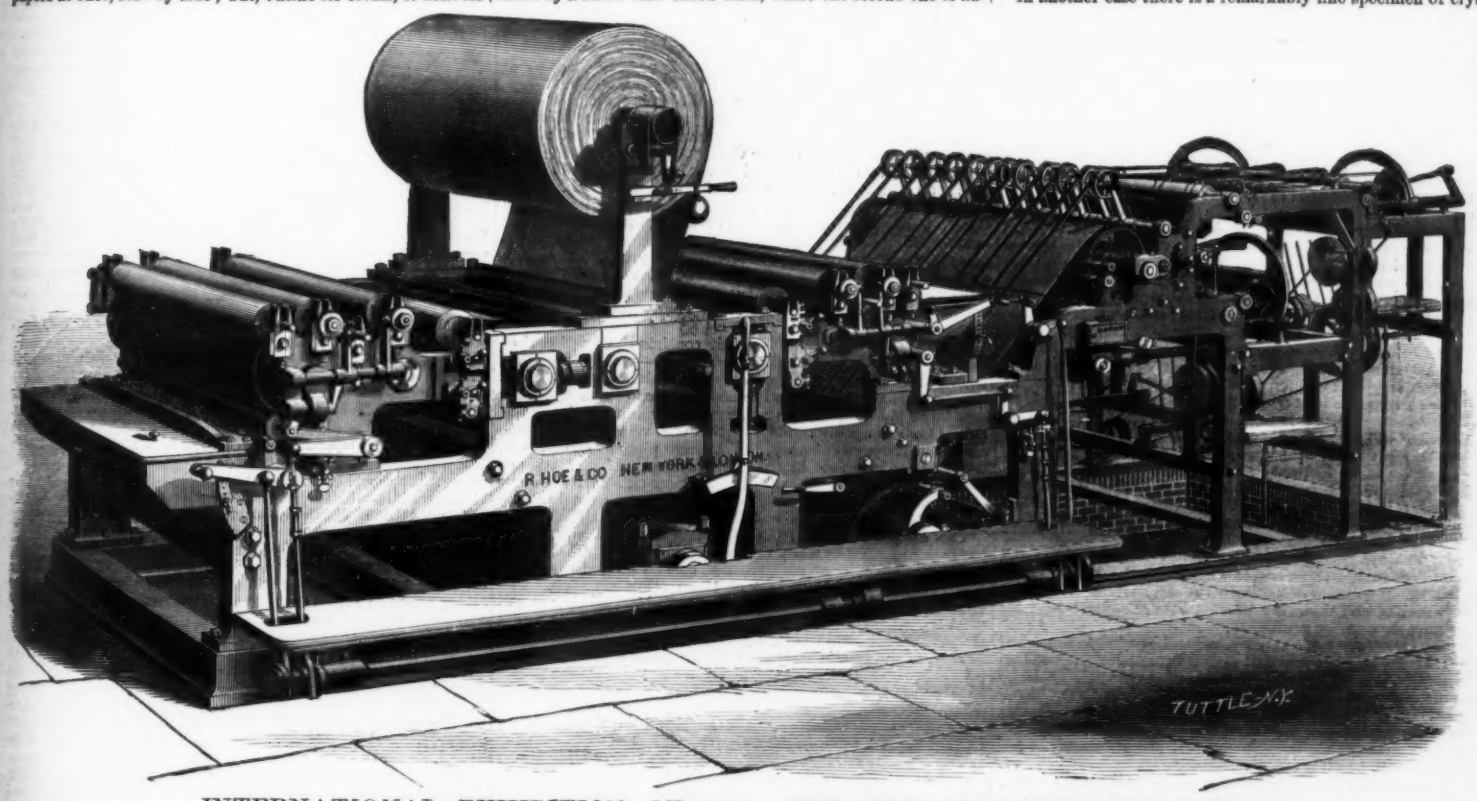
THE exhibits of printing presses in Machinery Hall are very extensive and complete, ranging from the smallest sizes of hand apparatus up to the largest web perfecting press. One of the latter, exhibited by R. Hoe & Co., of this city, we present in the annexed engraving.

The history of this type of press begins in 1835, when Sir Rowland Hill, who became famous for his advocacy of penny postage in Great Britain, obtained letters-patent for a web perfecting press; that is, a press capable of printing a roll of paper on both sides and cutting and piling the sheets. The difficulties experienced in this machine were owing partly to the use of conical type, and partly to the difficulty of disposing of the printed sheets. In 1853, Victor Beaumont, of New York, patented the serrated cutting blade set lengthwise in one of a pair of cutting cylinders, having elastic surfaces inserted to hold the paper on each side of the cutting blade when the sheet is cut from the web. To this device is largely due the success of all web perfecting presses. To France, however, belongs the credit of the invention which made such presses of practical value. A French inventor in about 1850 devised the process of stereopying with flexible papier-maché matrices, rendering it practicable to cast the type plates to fit the cylinders, and leaving but little to accomplish, save the sufficiently rapid disposal of the printed sheets.

The press exhibited by Messrs. R. Hoe & Co., at the Centennial Exposition, is a double machine, printing two complete papers at once, side by side; but, unlike its rivals, it delivers the sheets not flat, but folded. Its capacity ranges from 15,000 double to 28,000 or 30,000 single sheets per hour, according to the quality of the paper. The roll of paper is 52 inches wide.

The design of the press may be described as consisting of pairs of cylinders set in a massive framework four inches thick, compact and plain, having no oblique angles, but running either vertically or horizontally, as the case may be. To this construction, no doubt, is due the absence of jar, noise or vibration, which is a feature of this press even when running at a high speed. The first pair of cylinders, over which hangs the roll of paper, consist of one type and one impression cylinder. Here the first side of the paper is printed. The second pair, printing the second side, consist likewise of one type and one impression cylinder; but the latter is below the former, and is of much greater size, so that the set-off from the fresh ink shall not fall continually on the same surface of the blanket. In point of fact, it is only every fourth sheet which touches the same part of the blanket, which has therefore time to dry. The tympan is movable, so that should it get too black or become defective, it can be changed as follows: It is put up on the off-set cylinder in sections, each section having a roll at each end. At the beginning, the tympan of each section is all on one roller of each pair; and hence by unrolling that one, and rolling up the other, the change of tympan is effected in a very short space of time. The tympan-sheet is composed of muslin, there being ten yards in each section. From the second pair of cylinders the sheet passes to the third pair, which act as the cutting cylinders, the lower of which has inserted rubber jaws to receive the edge of the knife, which is provided in the upper roller, and operated by a cam movement so as to project the blade to perform its cutting duty and recede for the rest of the revolution. The sheet is not cut entirely in two, there being left small uncut sections about ¼ inch wide, which have just sufficient strength to hold the paper together until the tapes take hold of it and conduct it to the first folding cylinder, which folds each paper lengthwise. During the passage of the paper from the first to the second folding rollers, it is, for single sheets, cut across the width of the newspaper. After leaving the first folding rollers, the sheets are, by a simple spear-shaped switch, divided alternately between the upper and lower rollers, two papers to the lower and two to the upper alternately; and by this means the folder runs at but half the speed of the press, which gives to the folding machine a capacity equal to that of the press.

For putting the lower form-inking rollers in place in the press, there is provided a small travelling carriage upon which the bearing of one end of the roller may be placed, and the whole pushed rapidly across. These form-inking rollers are held in a small bracket operated by a small hand lever which locks the roller bearing in position, or releases it, as the case may be. The journal boxes of the large cylinders are of cast iron, with composition bushings. The distributing rollers are operated laterally by a triple thread-worm movement. The ink is taken from the distributing rollers by two 6-inch form rollers. The first type roller is adjustable for the impression by a horizontal movement of the bearings, regulated by a screw and check nuts, while the second one is adjustable vertically by a similar device. A register or counter is fixed to the frame, and is operated from the cutting cylinders by bevel gearing and a worm movement. The whole machine stands so low upon the floor that every part of it is under the pressman's eye, presenting quite a contrast to the Walter Press in this respect. Another, and notable, feature is that the plates, rollers, and smaller parts can be taken from the press at the sides and without ascending any steps. This is a great advantage to the printer. The workmanship throughout is of the first quality; the bearing marks show good fitting. The junction of collars, etc., with the faces show the truth of the work. The cut gears, which are covered to avoid accidents, work smoothly and show even contacts. The shafts of the impression rollers, type rollers, and folding cylinders are of steel; and all the links and connections are case-hardened, so that durability is assured. J. R.




INTERNATIONAL EXHIBITION OF 1876.—THE NEW HOE PRINTING PRESS.

## THE INTERNATIONAL EXHIBITION.

### THE COLLECTION OF MINERALS OF THE SMITHSONIAN INSTITUTION.

THE greater portion of the northwestern section of the United States Government Building, which was set apart for the exhibit of the Smithsonian Institution, is occupied by a collection of ores and minerals, gathered together for the purpose of illustrating the extent and variety of the mineral resources of the United States. It was made expressly for the International Exhibition, and under the direction of Professor William P. Blake, who now has charge of the collection.

The excellent representation from the Rocky Mountain and Pacific States is mainly due to the exertions of Hon. Thomas Donaldson, Centennial Commissioner from Idaho, who spent nearly two years in collecting specimens from every mine of importance in these States.

The greater part of the collection is arranged geographically by States and generally by the counties in these States; but the marbles, granites, and some crystallized minerals are arranged according to the nature of the specimens without regard to the locality from which they come.

At the close of the Exhibition it is designed to send the collection to Washington, where it will be on permanent exhibition in the National Museum.

The mineral exhibit from Nevada outshines that of any other State represented in the collection, both in quality and quantity of the minerals. The exhibit is placed in eight large black-walnut show-cases with plate-glass covers and sides. The small specimens are in the upper part while the larger ones are placed below. In the case nearest the main aisle there is a large quantity of ruby silver ore (both proustite and pyrargyrite), associated with stephanite, from the Reese River district, Lander County. Among these are several quite valuable specimens. One large piece of ruby silver with quartz, having cavities in the sides lined with crystals of pyrargyrite, and contributed by the Reese River pioneers, is valued at $300. There is also a large piece of nearly pure stephanite, with a slight sprinkling of argentite and pyrite, containing about 65 per cent of silver, which is valued at $200.

In another case there is a remarkably fine specimen of crystallized stephanite, with perfectly transparent crystals of quartz, from the Chase Mine, Lander County. The ores from this locality are remarkable for their richness, and the case with which they may be treated. The average assay is from $5000 to $10,000 per ton. The adjoining case is filled with a variety of Nevada minerals selected for their beauty and rarity. Among them are pieces of crystallized sulphur from Humboldt County, some large pieces of selenite from the same locality, several well crystallized specimens of wulfenite from Eureka Consolidated Mines, Eureka County, salt crystallized from brine and some pieces of native rock salt from Lincoln and Churchill counties. Besides these about a peck of garnets in the rough state, and some brochantite with specimens of sulphate of copper extracted therefrom, are shown in the same case.

The most interesting of all the minerals in this case are a few cubical crystals of native salt from Eagle Salt Marsh, Churchill County, which have a very peculiar structure. They are perfect transparent cubes, not cavernous, as salt crystals usually are, and each one shows a nucleus in the centre upon which layer after layer has been deposited until it attained its present dimensions.

The silver ores from the Comstock Lode fill four entire cases, and they represent all the mines on the lode and vicinity. The California and Virginia Consolidated have the largest and most complete set of specimens. The Crown Point Mine has some fine ores, which according to the assay have an average yield of $6440 of silver, and $5014 of gold, making a total of $11,454, per ton.

The Belcher, Gould & Curry, Savage, Ophir, Sierra Nevada,

and all the other large mines have specimens on exhibition, showing the richest and poorest ores taken out, and with each variety of ore an assay is given. From the Belcher Mine there are some very fine specimens of quartz crystallized in pyramids as well as prisms, together with numerous specimens of amethyst and chalcedony geodes. While we are on the subject of the Comstock Lode, it may be well to say that there is in this collection a model of the Sutro Tunnel, which extends from Silver City to Virginia City, at which latter place it penetrates the lode. The model is divided into four parts, shows a plan of the tunnel, extent of the different claims and geological sections.

All the other principal mineral localities in Nevada are well represented, but we have only space to mention a few of them.

From the Philadelphia district, Nye County, there are numerous specimens of native silver, cerargyrite, stetefeldite, argentite, etc. A large piece of tellurium silver or hessite, from the Prussian South Mine, Jefferson district, is exhibited, which is worth $400 for the silver it contains. It is a characteristic specimen of this kind of ore, and looks as if the alloy had been injected in the metamorphic rock, with which it is intimately associated. From the Mineral Hill district there is quite a display of silver ores, nearly all of which contain chloride of silver.

The soluble soda salts from Nevada seem to attract the attention of a great many persons, especially foreigners; and when they are told of the vast deposits now lying idle, they are usually much surprised. In the collection from this State there are specimens of tincal from Borax Lake, Esmeralda County, borax extracted from the waters of the borax springs in Churchill County, octahedral crystals of borate of lime from Fish Lake, crude carbonate of soda in strata as taken from the soda mines of Churchill County, and large quantities of rock salt from the Rio Virgin salt mines, in Lincoln County.

From California the exhibit consists chiefly of mercury, gold and silver ores. One entire case is filled with mercury ores from the principal localities, and showing a great variety of forms. From the mines at New Idria there are numerous specimens—one large mass weighing 300 pounds is of a pure vermilion color. There are also pieces of decomposed serpentine impregnated with cinnabar, which are rather peculiar.

From the Phœnix Mine, Pope Valley, Napa County, there are shown several unusually fine crystallized specimens of cinnabar, some of them associated with quartz, chalcedony, or limestone, producing a very beautiful flesh color. There are also specimens of cinnabar, though not crystallized, from Sonoma, San Simeon and Lake counties, and San José in Santa Clara County. From the Kearsarge Company's mines in Lake County there are some specimens showing native mercury, and some of them cannot be handled without globules of the metal rolling off. The most interesting specimens in the case, however, are some botryoidal masses of metacinnabarite, a very rare and comparatively new mineral, which is very nearly analogous to the black sulphuret of mercury of the laboratory.

The silver and gold ores of California are well represented. Most of the gold ores are quartzose, and show free gold in varying quantities, but there are some specimens of auriferous sulphurets. An entire section of the vein is shown from the Plumas Eureka Mine, Eureka County; and from the Idaho Mine, Grass Valley district, there is a fine specimen of auriferous pyrites with free gold imbedded in the solid pyrites. Another curious specimen from Lone Star Mine, Nevada Springs, consists of quartz with a cavity which once contained a large crystal of auriferous pyrites—shown by the striations—and which has decomposed, leaving the gold in extremely thin, irregularly shaped sheets. The "hydraulic" or "blue" gravel from the placers of California is shown in large quantities, and very choice specimens from different levels, together with the wall and bed rocks. Some of these specimens have nuggets of gold as large as one's little finger imbedded in the conglomerate. One piece about a foot square is valued at $200 for the gold it contains, while another piece about as large as a paving stone is worth $50.

Nearly one entire case is filled with the ores from different mines at Panamint, Inyo County. The ore is a decomposed fahlerz and quartz, stained blue and green with carbonate of copper, and it is worked only for the silver it contains.

Some tin ore (wolframite with $\frac{1}{2}$ per cent tin) from Temescal, is exhibited in one of the upright cases, together with pigs of tin extracted from the ore and American iron coated with American tin.

From Ventura there is a display of "Ventura rock soap," which gives an abundant lather when rubbed with water on the hands. It consists of kaolin with carbonate of soda and other alkalies, and is simply pressed into cakes and sold for toilet purposes, or for tooth soap.

There are, from Lake County, several specimens of a congeries of borax, sulphur, and cinnabar, which is treated so successfully that all of these articles are extracted. A large cake of sulphur, extracted from this mixture, is placed in the same case.

Colorado sends some fine samples of gold ores, which are mostly sulphurets, but there are several fine specimens of tellurium gold and tellurium silver (petzite and hessite). These latter are chiefly from the Cash, Baron Osceola, May Flower, American, and Charcoal mines, in Sunshine district, Humboldt County. There are numerous specimens of sulphide ores, which are so characteristic of Colorado, from many localities. The samples of auriferous pyrites from the Bates Mine in Humboldt County are very beautifully crystallized. Colorado also sends specimens of tertiary coals and clays, gypsum, and uranite, or pitchblende, from Jefferson County.

Montana deserves great credit for the excellent display of minerals which it makes. The greater portion of those were collected by Hon. J. P. Woolman, Centennial Commissioner from that State, while the remainder of the collection was made by Mr. Donaldson.

The collection comprises a great variety of ores and minerals. The specimens of argentiferous galena from Lewis and Clarke, Madison, Deer Lodge, and Meagher counties are very fine, and average a high assay. Some of them sparkle brilliantly, while others show a lively iridescence.

There are also samples of gold quarts, argentiferous copper ores, etc. But the most attractive exhibit from Montana, and I might say in the whole collection, is contained in a safe placed on the north side of the central aisle. The safe has a plate-glass front, and in it are shown forty or fifty specimens of wash gold and several quite large nuggets, one of them as large as a man's hand and weighing several ounces. These are from various placer diggings, the largest nuggets coming from Scratch Gravel Basin and Highland Gulches. There is also a very interesting and rare specimen of gold associated with tellurium, without an alloy having taken place. This piece is from the Uncle Sam Lode. As many as twenty or thirty crystals of gold, of various forms, from different places in Montana, are also shown in the safe, and they will prove of considerable interest to any one specially interested in the subject.

From the National Yellowstone Park there are exhibited with the Montana collection some fine geodes of amethyst and chalcedony. One of these pieces, which is unusually interesting, is hollow all through the centre, and is lined with beautiful crystals of amethyst, while the exterior is chalcedony. There are two large pieces of chalcedony, each about eighteen inches square, which excite the admiration of a great many people.

Idaho contributes some valuable specimens of gold and silver ores, nearly all of which show free gold or silver. The characteristics of these specimens are their quartzose gangue, and their being stained with copper or iron oxide. A few pieces of galena, some ruby silver, several opal pebbles from Snake River, cinnabar from Owyhee County, and some rich copper and silver ores from Laxey Bell Mine, are included in the Idaho exhibit.

The display from Oregon consists only of some auriferous quartz from Virtue Mine, Baker County, showing large quantities of free gold, and specimens of native salt.

From Utah four cases of copper, lead, and silver ores are exhibited. The ores are chiefly argentiferous galena and carbonate of lead, both of which are found in large quantities in Utah. The copper ores, all of which are argentiferous, are mostly from Tooele and Salt Lake counties. From the Little Cottonwood district, Salt Lake County, there are some specimens of argentiferous lead ores from the notorious Emma Mine, one piece giving an assay of $1428.55 per ton.

Arizona sends copper, gold, and silver ores, including considerable quantities of malachite, azurite, chalcosite, chrysocolla, and crystallized cuprite. From the celebrated Moss Lode there is a fine specimen showing free gold. A few specimens of wulfenite and crocoite are exhibited from the Sacaton Mine and from the Keystone Mine. In Yavapai County there are fine specimens of wire silver and pyrargyrite. A large piece of malachite from Young America Mine shows veins of cuprite running through it.

Virginia is represented by quite a variety of specimens. There is limonite from Alleghany County (used by Low Moor Iron Company), and from Amherst, Wythe, and Rockbridge counties; magnetic iron ore from Fauquier and Amherst counties; micaceous specular iron from Nelson County, and hematite from Smythe, Amherst, and Wythe Counties. The hematite from Wythe County contains carbonate of copper. Limonite used by the Mt. Vernon Iron Works, Rockingham County, is also shown, together with various grades of pig iron manufactured therefrom.

Auriferous copper and iron pyrites and quartz are exhibited from mines of Central Virginia Mining Company, Louisa County; and nickeliferous pyrrhotite and kupfer-nickel is shown from Wytheville, Wythe County.

The Union Lead and Zinc Company sends some smithsonite and galena associated with blende and carbonate of lead, all of which are from Wythe County.

The salt and alum springs and salt mines of Virginia are not forgotten, as the specimens on exhibition will verify. The salt exhibit includes rock salt of various degrees of purity from Smythe, Washington, and Wythe Counties; gypsum and sandstone which occur in the mines, and salt brine from Saltville, Washington County, and Wythe County. There are some alum and chalybeate waters from the Shenandoah Alum Springs, in Wythe County.

Coal is shown from several localities, notably from Little Walker's Mountain, where the vein is nine feet thick. Slate with fern impressions is also shown with the coal from this mine. A few other minerals and ores are sent from Virginia, among which are gypsum, barytes, steatite, sulphide of antimony, potters' clay, and pyrolusite from Wythe County; copper pyrites, with galena in mica schist, from Carroll County; infusorial earth from Richmond, and some stalactites of carbonate of lime from the celebrated Fountain Cave, in Rockingham County.

From West Virginia the exhibit consists chiefly of coal of various qualities, and from various mines—mostly, however, from those of Kanawha County. The Cabin Creek, Cannelton, Kanawha and Ohio, and some other coal companies, have sent large pieces of coal to represent their mines. The Cannelton Coal Company sends a section of a vein of bituminous coal from Kanawha County, and a large piece of cannel coal, which is used for enriching illuminating gas. The section of coal is eight feet high, and two feet by eighteen inches at base, and this, together with the large piece of cannel coal, is mounted on a tasty black-walnut pedestal in the main aisle.

The collection from North Carolina is very choice, and is composed of a great many crystallized minerals. There is a very complete suite of specimens of corundum and associates from Macon County, and two or three other counties. The display from the Jenks Mine, Macon County, is by far the most attractive. It comprises specimens of corundum found alone, cleavage masses of ruby and sapphire associated with corundum and smaragdite, and eight sapphire crystals, cut and polished, three or four of which have a very homogeneous blue color, while the others are more or less imperfect in color.

The corundum mines of North Carolina are quite extensive, and are rapidly increasing in value.

The show of mica from this State is also quite interesting. There are large sheets of mica nearly two feet square, and other smaller pieces which have internal markings, showing that the crystal has been revolved upon itself. The most interesting specimen, however, is a piece of perfectly clear muscovite, with a hexagonal crystal of biotite in its centre, giving one at first the impression that the latter was pushed between the sheets of muscovite by the hands of some person, but when examined closely it shows unmistakable signs of having been formed there by natural means. The gold-bearing regions of North Carolina are not very well represented, but a few rich specimens are shown from Gold Hill, which are auriferous sulphides of iron more or less decomposed. A collection of small specimens of marble, polished and of various colors, is exhibited from Swain, Macon, and Cherokee counties.

There are many other varieties of minerals from North Carolina, some of them being very well crystallized. There are staurolite from Cherokee County; garnets, asbestos, genthite, barytes, and gypsum from Macon County; graphite from Wake County; beryl from Mitchell County and some beautiful translucent agalmatolite from Nanteyalee, Swain County. Besides these minerals, some varieties of iron and copper ores are exhibited.

The principal exhibit from South Carolina is the fossil phosphatic rock, marl, etc. The region of the phosphatic deposits is well represented by specimens from Ashley, Coosaw, Bull, Stono, and Wando rivers, and other places in the vicinity. There is also a large piece of Eocene phosphate from Ravenall's Mine, near Woodstock. Standing at the end of the show-case are two large masses, one of phosphatic rock from Ashley River, and the other of phosphorite from Navassa Island.

A great variety of fossils gathered from the phosphate rock are shown with the collection. They include fossil sharks' teeth from one quarter of an inch to four inches in length, horses', elephants', and mastodons' teeth, sections of vertebræ of mastodon, milobites holmesii (roof of shark's mouth), cranium of zeuglodon, coprolites, head of dinotherium, mastodon tusks, and a proroziphius macrops (Leidy) which is unusually perfect.

Besides these phosphate rocks from South Carolina there are exhibited a few ores and minerals, including a variety of corundum crystallized in scalenohedrons from Laurens County, specimens of white and mottled marbles, feldspar, fluorite, granite, gold-bearing quartz, serpentine and smoky quartz from the same locality. There are also some very large sheets of mica from Walhalla; infusorial earth, used for making dynamite, from near Columbia; auriferous pyrites, hornblende, green quartz, and argentiferous galena from Oconee County.

The display from Georgia is composed of a few specimens of gold-bearing quartz from Nacoochee, White County, and from Union County; and some infusorial earth of good quality from near Augusta, in Richmond County. In addition to these there is a collection of geological specimens of Georgia, sent by Professor F. H. Bradley, including some iron ores.

From Kentucky there are exhibited some iron ores, coal, and limestone, collected from various localities by the Geological Survey of the State, and some excellent lithographic stone from Eastern and Elizabethtown.

Dr. Geo. W. Chapman, of Kansas, sends a large and interesting collection of septaria from Waconda, in that State. Some of these specimens are broken open, and the fossils can easily be distinguished in the centre.

Tennessee sends a very large collection of ores. The display is very creditable, although it is not arranged in the best way possible. General Wilder, of Chattanooga, contributed nearly all of the specimens, excepting about twenty or thirty pieces of iron ore, barytes, etc., from Professor Bradley.

Pig iron made from several varieties of these ores is also shown, the ends of the pigs being fractured so that the texture can be seen. There are coal which makes good coke, and limestone used in fluxing the iron ores from several of the counties. One large piece of coal is exhibited which was taken from a vein 104 feet thick.

Some manganese and zinc ores are found in Tennessee, and these are represented by specimens of psilomelane from French Brook, and smithsonite from Jefferson County.

The ores of iron shown include a large quantity of magnetite, brown and red hematites from Johnson, Dickson, Cocke, Stewart, Roane, Carter, James, and many other counties in the State. Much of the red hematite is fossiliferous, especially that from the vicinity of Chattanooga. The magnetic ore from Carter County is mostly from the Crab Orchard Mine, the result of five analyses being as follows:

*Analyses of Magnetites from Carter County, Tennessee.*

| MAGNETITES. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. |
|---|---|---|---|---|---|
| Iron as Magnetic Oxide, and Sesquioxide | 68.34 | 69.08 | 67.63 | 58.19 | 67.89 |
| Manganese Oxide | .26 | .24 | .27 | 1.42 | .25 |
| Alumina | .42 | .28 | .41 | .53 | .34 |
| Magnesia | .36 | .33 | .35 | Trace. | .36 |
| Lime | .43 | .39 | .41 | Trace. | .27 |
| Silicic Acid, and Silicates | 4.88 | 4.43 | 4.68 | 9.06 | 3.73 |
| Titanic Acid | | | | | 5.87 |
| Phosphoric Acid | Trace. | Trace. | Trace. | Trace. | Trace. |
| Oxygen, Water, etc. | 25.30 | 25.15 | 26.25 | 30.79 | 21.36 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

The fossiliferous marbles of Tennessee, which are very fine, will be mentioned further on.

The exhibit of Michigan shows in a very striking manner the immense resources of this State in iron and copper.

The collection of native copper from the Lake Superior region is very fine, and includes many crystallized specimens. One entire case is filled with the sandstone conglomerate, with bed and wall rocks from the celebrated Calumet and Hecla Mine. The wall rock is principally epidote. From the Cliff Mine there are specimens of native copper in quartz and calcite, as well as native copper associated with native silver. The crystallized specimens of native copper from this mine are unusually fine, some of the crystals being very perfect. The mines at Copper Falls are represented by specimens of copper conglomerate, native copper disseminated through calcite, and other choice specimens of native copper and native silver associated together. From Ontonagon there are two or three specimens of native silver free from copper, and numerous crystallized specimens of native copper.

The Phœnix Mine comes next to the Calumet and Hecla in the extent of its display. The specimens are of various grades, some being crystallized, while others show the associating minerals and wall rocks. There are a few specimens of cuprite and malachite from the Lac la Belle Mine, Lake Superior, in which region such ores of copper are not often found.

Several stone hammers in the cases are placed there to show the style of tools the aborigines in this locality worked with; and resting against the end of one of the cases is a large piece of mass copper, weighing 3000 lbs., which bears the imprints of similar stone hammers.

The collection of Michigan iron ores is very good. It includes all varieties of hematite, the micaceous specular, granular, red, etc., some of them being nicely crystallized; together with limonites and magnetites from all the chief localities. From the Jackson Mine there are some large pieces of hematite from No. 5 pit, weighing three or four tons each. From Marquette some peculiar pieces of kidney ore are exhibited, and from the Republic Iron Company a fine large piece of micaceous specular iron is shown. The Spur Mine sends specimens of ore, together with wall rock containing large crystals of garnet. The Barnum, Michigamme, New York, and all the other principal mines are well represented.

Missouri has an excellent exhibit of her ores and minerals. Most of the specimens were collected by G. C. Broadhead, State geologist, and are characterized by their fine appearance and variety of localities which they represent.

From Joplin and vicinity there is a large number of specimens of lead and zinc ores, some of them beautifully crystallized. A very unique specimen from the Davis & Murphy Mine consists of barytes intermixed with tetrahedrons of chalcopyrite and large cubical crystals of galena. The zinc ores include blende, calamine, and smithsonite, occurring alone and associated with galena. There are also from Joplin specimens of galena crystallized in octahedrons as well as cubes, native asphalt found in the lead mines, and some pieces of cock's-comb barytes covering galena, all of which are very interesting.

The iron ores of the Joplin region include well crystallized specimens of specular and micaceous specular iron ores, to-

gether with limestone, quartz, feldspar and calcite used in the furnace. Pilot Knob, Iron Mountain, Knob Knoster, and many of the less important iron regions are represented by a great variety of ores, as well as coal and flux used in smelting, and pig iron manufactured from the ores. There are large masses of ore from some of these localities. One piece from Iron Mountain, presented by Mr. Edwin Harrison, weighs seven tons, and has the appearance of a huge hexagonal pyramid.

The Mine La Motte sends some very choice specimens of galena crystallized in octahedrons and rhombic dodecahedrons modified by cubes. There are from the same locality pieces of well crystallized marcasite and linnæite. Some specimens of barytes which resemble ivory on the edges of the crystals are very interesting, and from Newton County tripoli of good quality is exhibited.

The collection from the State of Pennsylvania comprises mostly iron, copper, zinc, nickel, and cobalt ores, and coal.

Mr Joseph Wharton makes a fine exhibit of nickel and cobalt ores from the Gap Mine, Lancaster County, together with a complete series of products made from these ores at his works in Camden, N. J. The ores are chiefly nickeliferous, pyrrhotite and millerite, both containing more or less cobalt. There is next a suite of mattes and slags, formed during the process of reduction, and nickel and cobalt in cast plates or anodes for batteries, and in cubes and wrought bars for the use of electro-platers. Next comes a variety of salts of cobalt and nickel used in the arts, including double sulphate of nickel and ammonia used for nickel-plating, the chloride, sulphate, acetate, and oxide of nickel and a corresponding series of cobalt salts. There are also in this exhibit specimens of nickel and cobalt plate on different metals, and several alloys of nickel with zinc or copper, such as German silver, nickel three-cent and five-cent pieces, etc. The most interesting things, however, in the case are a nickel horseshoe magnet and a nickel magnetic needle, both of which are quite feeble. The horseshoe magnet is able to hold up four or five nickel-plated key rings.

Copper is also extracted from much of the ore from the Gap Mine, and specimens of the products are shown with Mr. Wharton's exhibit.

From the Cornwall ore banks of Lebanon County there is a fine exhibit of iron ores and pig iron made at different furnaces with this ore.

Mr. Douglas, of the Chemical Copper Company, of Phœnixville, has a collection of copper ores from the Cornwall banks, and from Berks County, which are treated at the works of this company by the Hunt & Douglas method. A complete suite of products of this method is shown, and some jars contain the precipitated copper in beautiful feathery crystals. An ore containing only 2.8 per cent copper can be successfully treated by this process.

Mr. Wheatley, of the Schuylkill Copper Works, Phœnixville, exhibits specimens of ores which are smelted at the works which he represents. There is also with these ores a set of furnace products, illustrating the different stages in the reduction of the copper from the first fusion to the production of the finished ingot.

The Lehigh Zinc Company exhibits zinc blende and calamine from Friedensville, Pa., which are used at the works of this company at Bethlehem. Spelter made from each of these ores and sulphur extracted from the blende are also shown.

Anthracite coal and a great many fossil coal plants from mines in Pennsylvania are to be seen in the collection. The Philadelphia and Reading Coal and Iron Company has erected on the trophy in the centre of the Government Building a column of anthracite coal, which is a section of the mammoth vein at Plank Ridge Colliery, near Shenandoah, Schuylkill County. The thickness of the vein, and consequently the height of the column, is 44 feet. The column is supported by an iron framework put up by the Phœnix Iron Company. Around the base of the trophy are grouped various products of the soil and mine, including masses of marble, copper, iron, nickel, and zinc ores, together with sheaves of cereals, bales of cotton, hogsheads of tobacco, casks of wine, etc. The copper ores exhibited from Pennsylvania include chalcopyrite from Chester and Montgomery Counties, chalcocite and variegated copper from Montgomery County, magnetite containing chalcopyrite from Berks County, and numerous specimens of malachite containing 38.62 per cent copper, copper pyrites with 31.94 per cent copper; and native copper from the Cornwall ore banks.

Chromite, both washed and as it is found in Delaware County, and fire clays, together with bricks made therefrom, are well shown.

New York has a large exhibit of iron ores from all the principal localities in that State. The Crown Point Iron Company sends a collection of magnetic iron ores with wall and bed rocks of the mines. Samples of charcoal and flux used in smelting, and pig and wrought iron made from this ore, are included in the exhibit. Port Henry, Moriah, and the chief iron-ore mines of the Lake Champlain region are well represented, some of them by large masses weighing from one to six tons. From Rossie and Clinton there are specimens of the fossiliferous red hematite, characteristic of the Clinton group; and from Putnam County there are pieces of magnetite from various mines. Some beautifully crystallized specimens of magnetite, with Jenkinsite, are shown from the O'Neil Mine, Orange County; and from several mines in Dutchess County there are large pieces of limonite, one from the Manhattan Mine showing considerable turgite. From East Fishkill there are exhibited two or three pieces of melanosiderite.

The Copake Iron Works shows some fine specimens of charcoal pig iron of all grades, each piece being fractured at both ends and chilled at one end. Some graphite is exhibited as found in its native state at Black Mountain, near Clintonville, and as prepared for various purposes, such as electrotyping, making pencils, etc.

The Capital Lime and Cement Company makes a display of hydraulic limestone from Rosendale, together with samples of cement made therefrom.

Adam Weber and B. Kreischer & Son, of New York City, have exhibits of fire clays and materials made therefrom, including gas retorts, muffles, fire brick, furnace tile, and a variety of curiously shaped articles. Some specimens of rose quartz and feldspar from Essex County, used in the manufacture of pottery, finish the display of New York.

New Jersey exhibits some fine specimens of zinc and iron ores. From Franklin and vicinity there is a great abundance of zinc ore, including zincite, franklinite, and willemite, associated with calcite and numerous other minerals. There are several large boulders and masses of this ore piece representing a section of the vein, while others show dikes or faults. In the glass cases are several very beautiful specimens of ruby zinc ore, and some yellow translucent crystals of willemite and crystallized franklinite occurring alone, and associated with the other minerals. Most of these specimens were presented by the New Jersey Zinc Company.

The Passaic Zinc Company sends a fine lot of crystallized calamine and franklinite, together with spelter and zinc oxide prepared from these ores. Some sussexite, rhodonite, fowlerite, etc., are shown with the rest of the minerals.

Besides the zinc ores there are exhibited iron ores from nearly all the principal mines in New Jersey. The ores are mostly magnetites, and Morris, Essex, and Sussex counties are better represented than any of the others. Cooper & Hewitt send a lot of magnetites and limonites from different mines near Trenton, with limestone used as flux and pig iron made from these ores.

Mr. Edward H. Fletcher, of New York, makes a loan exhibition of minerals from Bergen Hill, some of which are very handsome. New Jersey also makes a good exhibit of clays for making pottery, china-ware, etc.

Massachusetts has a good representation of the recently discovered argentiferous lead ores from the vicinity of Newburyport, and also a few specimens of a similar ore, though not so rich, from other mines in the State.

James T. Ames sends from Chester a very neat collection of emery and associates, the latter including soapstone, diaspore, hornblende, margarite, andesite, etc. One large piece of emery rock shows crystals of diaspore on one side.

Barytes from Cheshire fills part of one case. This mineral is now being largely used for the manufacture of paint by mixing with white lead or zinc oxide. A display of Berkshire sand, which is as white as snow, is made on a little stand in the side aisle. Some large pieces of glass made by using this sand help to make the exhibit a very attractive one.

From Vermont there is quite a good exhibit. The Vermont Copper Mining Company, of Ely, Orange County, sends samples of copper ore, chiefly copper pyrites, and a suite of furnace products illustrating the different stages in the manufacture of copper. Limonite is shown from Burlington, South Wallingford, and a few other localities. That from South Wallingford is manganiferous, and is adapted for making spiegeleisen.

New Hampshire has no other exhibit than a set of geological rocks presented by Professor Hitchcock, the State geologist.

Connecticut has some good limonite iron ores to show, some of which contain turgite. Barnum, Richardson & Co., of Salisbury, send a large piece of their ore, which is limonite. From Roxbury some siderite or carbonate of iron is sent, but, like most of the New England States, the exhibit of Connecticut is chiefly of marbles and granites. Rhode Island sends one large mass and two barrels of graphitic anthracite from the coal fields of that State.

The collection of marbles, granites, and building stones comprises some of the finest specimens to be found in the whole Exhibition. It is arranged without regard to geographical localities, and the specimens are exhibited as polished slabs 2 feet by 4 feet by 2 inches, and as 12-inch and 6-inch cubes, polished on one face, rough dressed on another, and showing the fracture on a third.

The Rutland Marble Company, of West Rutland, Vt., has the largest exhibit. It embraces various grades of marble, from the white statuary to the mottled blue and beautiful "Brocadilla" marbles. Besides these dressed specimens, this company sends some large masses of statuary marble, one of which weighs ten tons, is fine grained, and perfectly white.

There are also marbles from the Columbian and Eureka Marble Companies of Rutland, and from Ripley & Sons, of Centre Rutland, Vt. From Sutherland Falls, East Dorset, and Mallett's Bay there are fine specimens of marble, those from the last-named place being of very beautiful variegated red and brown colors. George Barney sends some marbles from Swanton, Vt., which are adapted for tiles. The "Le Panto" and the "Lyonnaise" are the most attractive. The latter marble, which is a mottled brownish-red and white, is used in the floor of Memorial Hall.

From Moriah, N. Y., and Roxbury, Vt., some specimens of verd antique are exhibited; and from Lake Champlain, Vt., and Hawkins County, Tenn., there are shown fossiliferous marbles, which are exquisite.

A variety of limestone from Charlotte, N. C., called leopardite, from its resemblance to a leopard's skin, is very interesting; and some eocene-shell limestone from Newbern County, N. C., used for building purposes, is worth examination.

The collection of granites, although not so complete as that of the marbles, is still very good. Some of the finest specimens are from Quincy, Mass., and Westerly, R. I. A large polished slab of very fine-grained granite from the quarries of the New England Granite Company, at Westerly, measures 3 feet by 6 feet by 4 inches, and attracts considerable attention. From Leete Island, Ct., Blue Hill, Me., and New Haven County, Ct., there are cubes of red and gray granites of superior quality.

A few specimens of dressed brown sandstone from Portland, Ct., East Long Meadow, Mass., and Anson, N. C., complete the collection of building stones.

Besides the ores and minerals already described, there is in the northwestern corner of the building a loan collection of crystallized minerals from the private cabinets of Rev. Dr. E. R. Beadle, Theodore D. Rand, Joseph Wilcox, and Clarence Bement, of Philadelphia, and William W. Jefferis, of Westchester, Pa.

This collection contains some exquisite specimens. It was not designed for a representative collection of all the crystallized minerals of the United States, but to show the rarest and most beautiful forms in which some of these minerals occur.

Messrs. Park Brothers & Co., of the Black Diamond Steel Works, Pittsburg, Pa., have an interesting exhibit illustrating the manufacture of crucible steel. The collection embraces specimens of Lake Superior and Iron Mountain hematites from all the different stages of its manufacture into steel, together with ingots of steel and various manufactured articles, such as pickaxes, knives, boiler-plate, wagon-springs, etc. Some of the ingots are broken to show the fracture, and bent or twisted to show the tenacity, while from others tools are drawn and finished. A column in the centre of the exhibit is composed of steel rods, bars, etc., of various sizes and forms, as manufactured for the trade.

Messrs. Hussey, Wells & Co., of Pittsburg, have a case in the side aisle containing a number of specimens illustrating the process of the manufacture of crucible cast steel in all its stages and with different qualities of iron. The fronts of the crucibles in which the steel was prepared have been removed, so that the contents can be seen.

The Albany and Rensselaer Iron and Steel Company, of Troy, N. Y., have an exhibit of Bessemer steel, which is placed in the central aisle. A large shaft, fractured at the upper end, supports a hexagonal framework of wood, around which car axles, rails, crowbars, boiler-plates, rivets, etc., are arranged. Many of these articles are twisted or bent cold to show tenacity.

Collins & Co., of Hartford, Ct., contribute some samples of steel used at their works, and a suite of specimens to illustrate the different stages in the manufacture of the axe.

From Tatham & Co., of Philadelphia, there is a very tastefully arranged exhibit illustrating some of the uses of lead. It consists of a cone of tin-lined lead pipe, about six feet high, placed on a black-walnut pedestal. Around the sides of the pedestal are arranged samples of sheet lead of various weights and degrees of thickness, from one to twenty pounds per square foot; lead pipe of different diameters and degrees of thickness, and shot of all sizes from dust to buck-shot. There are two meteorites on exhibition with the collection: one, the famous "Tucson" or "Irwin" meteorite, from Arizona, was brought from the Smithsonian Institution at Washington, on purpose for exhibition here. The other, the "Blake" meteorite, is from Tennessee, and has a very peculiar oblong shape. During the warm weather this summer this meteorite exuded drops of chloride of iron. A more detailed description of the meteorites is given in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 43, p. 671. M. S. T.

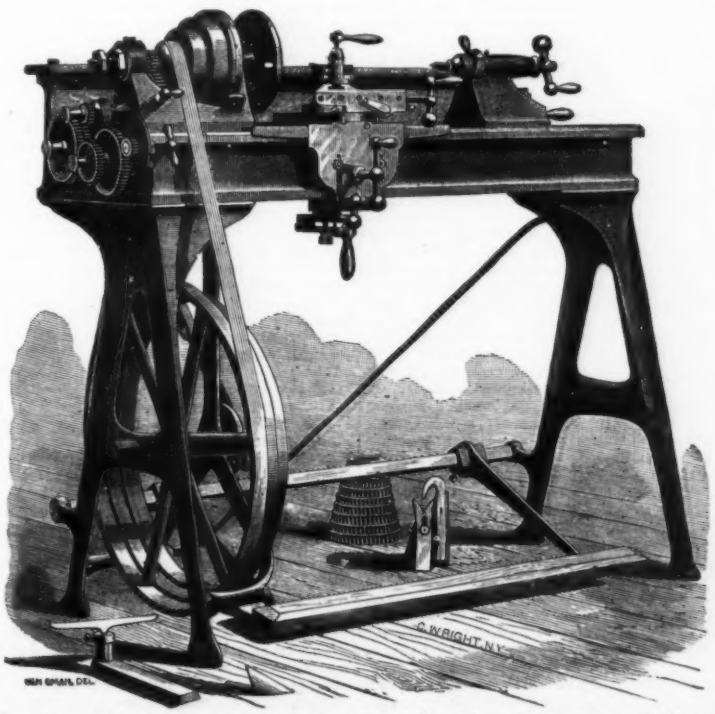
## THE HANDIWORK OF APPRENTICES AT THE CENTENNIAL EXPOSITION.

By JOSHUA ROSE.

### THE EXHIBIT OF THE IMPERIAL TECHNICAL SCHOOL, MOSCOW.

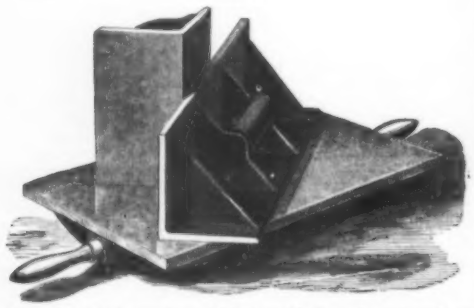
FOUR of the prominent exhibits in Machinery Hall are distinctive as being produced by apprentices, and the largest of these is that of the Imperial Technical School of Moscow, Russia, whose entries are very complete, the object being to show rather the course of the studies, than to pick out individual specimens of good salable workmanship. In this respect the display stands alone. The whole course of study shows that the professors are themselves practical mechanics, for every piece of work in each course has a distinct purpose, and could not be omitted without the loss of a definite and useful experience. In the prospectus of the school we read as follows: "No one will deny that a close acquaintance with hand labor, and a general practical experience in mechanical works, are matters of the utmost importance to every mechanical constructing engineer. The drawings of an engineer thus trained will always be distinguished by solid-

FIG. 1.



lity, and that practical judgment which is the result, not only of scientific truths, but also of the acquirement of a certain familiarity in their application to practice." Now, as if to give point to these very remarks, we find, on the drawings exhibited, red lines denoting those parts which require to be left larger on the pattern, so as to allow for machine manipulation and finishing, and on some of them the radius lines of curves are also marked so as to facilitate the operations of the workmen in lining out the work. To make such a drawing one must have a fair knowledge of pattern-making, as well as of moulding, since the draughtsman determines which way the pattern shall be moulded. This may not be, in all cases, absolutely necessary, but it is always highly advantageous, providing the designer is equal to the task. The cost of producing machinery is very often largely increased because the draughtsman has kept in view the designing only, without any reference to the best, strongest, and readiest way of making many of the parts.

FIG. 2.



The exhibited samples of blacksmith's work and tools are fifty-four in number, of good design and neatly made. In those having eyes to receive the handle, the eyes are well rounded, from the centre outwards, on each side—a matter in which most of our own blacksmiths and tool-makers are generally deficient, and hence loose handles, so often met with. The list of tools includes the usual swages, mandrils, fullers, tongs, sets, etc., to none of which can any exception be taken, save it be to the hand hammers, of which there are two. The first of these is of the pattern known in England as the fitter's hammer, and in the United States as the cross-pene hammer. The second is known in England as the cross-pene hammer, and in the United States as a chipping hammer. The blacksmith's hand hammer, weighing about 1½ lb., with a ball pene at the small end, and provided with a long handle, as used in all the principal blacksmiths' shops in both England and the United States, is conspicuous by its absence.

FIG. 3.

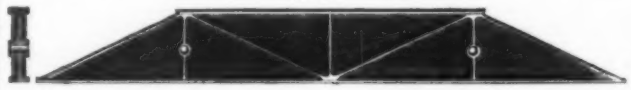
The samples of blacksmithing are certainly admirably chosen, as also well executed. Commencing with examples of forging square iron out of round iron, they include the production of round out of square, octagonal out of square, hexagonal out of round, and thence advance to the more difficult bolt heads.

Various kinds of flanges, eyes, and ears are taken up when welding is studied. These include the welding of washers or rings, scarf welding, split welds, pipe welding, and jumped welds. In bending, we are presented with flat iron bent to a right angle, the corners being brought square and neat. Next we have bent squares, welded squares, steel welded to iron, a welded cross, etc. The whole course of examples is progressive from beginning to end. We may now notice the turning tools. To the first examples—namely, the centre punches—there is the objection that they appear to be made of round steel, which is not, as a rule sufficiently refined at its centre to stand the heavy duty to which this tool is subjected. The chipping chisels are not made of octagon steel after the American pattern, but of a special steel made and used in England for chipping chisels only. It is flat on the top and bottom, and rounded on each side, and is admirably shaped for the purpose of holding in the hand. Samples of the old-fashioned hook tool are shown, serrated at the bottom so as to take a firm grip on the rest. Chisel, square, round, and V-nosed hand tools are shown, together with front, side, parting, and spring tools for use in the slide-rest. The callipers can not be said to be finely finished, but their shapes at the points are more correctly formed than is usually the case. There are several drivers or clamps with movable centres, which are admirably designed for throwing work out of the centre. A set of hand chasers, together with the hubs for making them, are shown, their sizes being, according to the English practice, denoted by the sizes of the iron they are intended to thread; thus the catalogue says, "Screwing tools, from $\frac{7}{32}$ to 1½ inch diameter, according to Whitworth's scale." Of plain and screwed mandrils for nuts there are shown several specimens under the name of "pikes."

In the samples of outside turning work there is a plain cylinder, a bolt with a cylindrical head, a handle for a vise, a bolt with a "fashion" head, besides exercises of various channellings, and their stepped gauges, so that the examples furnish first plain cuts, next a plan and flange, then next a head and curve, then a curve and sweep, next a long taper and curve, followed by ogee sweeps and curves, and square shoulders, and so on, progressively. In chucking, the examples are, 1st, a pulley; 2d, a cylinder, entailing the first boring lesson, next a cylinder with a *taper* bore; 3d, a shell for a step; 4th, a ball turned upon an axle; 5th, a finished ball; 6th, cones requiring sharp centres, and hence chucked. Then begins screw-cutting by hand chasers. So far all the examples have been of wrought iron, but here brass work begins: first, a stop cock and various grease-cocks, involving the fitting of cones; next, various conical valves, involving the fitting and grinding of seats while in the lathe; then a pair of connecting-rod brasses. We now come to a spindle and movable socket for a marking gauge, forming a lesson in work very liable to spring away from the cutting tool; also an eccentric, necessitating chucking in such a way that the strap can be tried on in the lathe.

A steam cylinder affords practice with the boring bar. A steam piston with a brass ring gives experience in the amount to be allowed, in such cases, for the expansion of the brass when under steam. A part of a governor necessitates the counterbalancing of the work on the face-plate of the lathe, and a cross-head offers an example of necessarily very exact chucking. Then comes a steam piston with cast-iron rings, as an example in the springing of work due to removing the surface skin. The last example is a crank shaft, involving plain turning, chucking, and counterbalancing, and requiring to be very true.

FIG. 4.



In the examples of drills and drilling there are drills intended to cut revolved either way, such as were used by a string or fiddle bow; lip drills, twist drills, pin drills, countersinks, and a countersink for brass. In all these examples the advantage of having the drill point as thin as is consistent with the necessary strength is plainly inculcated; while in the last mentioned countersink the cutting edge is a right-hand spiral, by which means it can be given a little rake without having any tendency to rip into the work.

The examples of tools and the specimens of vise work are not perhaps quite so noteworthy as those for lathe work. Samples of files, with the teeth greatly enlarged, show plainly the shapes of the teeth. The examples of chipping, flat, conical, convex, and concave surfaces are all well executed, and the examples of filing are complete and progressive. They consist, however, largely in the production of simple surfaces and apertures, and insufficiently perhaps in the matter of fitting parts together. This is no doubt due in a great measure to the fact that but seventy-two days in all are devoted to vise work, in which time it is impossible to crowd more examples than are here given.

The next entry is a marking-off table and a complete set of instruments, and samples of various classes of work are shown already marked off, in red lines, merely intended to instruct, being too coarse for actual workmanship. The display includes also various patterns and a few constructed machine tools. The former can not well be examined, because they are thickly coated with black varnish. They are, however, notable as being of good mechanical design.

### THE CORNELL EXHIBIT.

The next exhibit is that of the students of Cornell University, under the tutelage of Professor Sweet. The entries include a foot lathe, shown in our engraving, Fig. 1, the particulars of which are as follows: It will swing 10 inches, and turn straight and taper 6 inches in diameter (over the slide-rest), and 26 inches long. The automatic feed has three changes of feed in addition to eleven change gear-wheels, by which twenty-six different pitches of threads may be cut, varying from four to sixty-four threads to the inch. The slide-rest is adjustable at the upper or cross slide, so that it may be set to any cone for either outside or inside work, the angle being determined by an accurately graduated circle. The upper part of the rest is also removable, so that a hand-rest may be inserted in its stead. The washer on the tool-post is rounded instead of being hollowed or cupped upon the upper face, and above the washer is inserted, through the tool-post slot, a packing piece flat upon its top and hollow to fit the washer on the bottom face, so that the dirt will not accumulate and obstruct the movement of the device; and hence the height of the tool can be very readily adjusted without the annoyance due to the turnings, binding, and cutting the surfaces, as is so commonly the case. The tool-post is provided also with a lever arrangement, by which the tool can be withdrawn during the back traverse of the tool in screw-cutting operations; hence the feed-screw need not be wound back, and the depths of the cuts may be made both more exact and uniform. The head-stock is provided with a three-lift cone, and internal back-gear, changed by a single action. It has also a hollow mandril and a graduated face-plate. The friction feed may be changed very quickly, and is thrown out of gear by the device which throws the screw-cutting gear into action. The leg at the foot of the lathe is pivoted in such a manner that the bed will not be affected by an uneven floor. The disk crank admits of the crank-pin being changed to the left of the treadle. The lever and connection to the crank are so arranged and proportioned as to give more than half a revolution of the main wheel during the down and less than half a revolution during the up stroke. In fact, every part of the design is admirably adapted to its purpose, and to obviate the practical defects and difficulties so often met with in foot lathes, while the workmanship throughout both in fit and finish is very superior.

The standard surface plates shown in our engraving at Fig. 3, and the angle surface plates shown at Fig. 2, are probably the best specimens of scraping exhibited in the Exhibition. Fig. 4 represents a straight-edge, and Fig. 5 a machinist's square, the workmanship of which is fully equal to that on the surface plates, and the design of which is admirable. The measuring machine and the stationary engine exhibited by the University, we have already described in a former issue. It only remains to be said that this whole exhibit is what might have been expected from the indefatigable exertions of Professor Sweet, to whom the duties of his profession are a labor of love.

### EXHIBIT OF THE WORCESTER FREE INSTITUTE.

This technical school, which is located at Worcester, Mass., is in its scope and purpose essentially like those in Europe, but it gives especial prominence to practical mechanical manipulation. The apprentice class spend forty-two hours a week in the shop, and the course of study for mechanics is a half year longer than that for other students.

As specimens of the workmanship of the Institute, there are exhibited a 16-inch engine lathe, complete, and the whole of the working parts of a similar lathe not put together, so that the workmanship may be minutely examined. The lathe spindle is of steel hardened, and subsequently ground true. The bearings are coned with a suitable adjustment arrangement to take up the wear. The back gear of the lathe is thrown into and out of gear by a lever and eccentric motion in front, and a screw feed for thread-cutting purposes at the back. The tail stock is arranged to set over for turning tapers. The belt cone is made much broader than is usual, thus remedying a defect too often found in lathes. The bed is 8 feet long, and has raised V's for the slide-rest, the top surface of the V's being rounded to prevent the lodgment of dirt or grit. The workmanship on this lathe is highly commendable for its accuracy of fit, while for finish it equals almost any exhibit at the Centennial. The gearing is cut smooth, and runs very quietly.

A small lathe, termed a speed lathe, also in this exhibit, is simple in construction, handy, and well made. It has cone bearings, and a hardened spindle.

### THE APPRENTICES' LOCOMOTIVE.

We now come to a locomotive exhibited by the Philadelphia & Reading R.R. Co. This engine has hanging upon its side a picture frame containing the portraits of the apprentices who made the engine, and just beneath this frame stands a connecting-rod end so badly fitted, that a three-cent

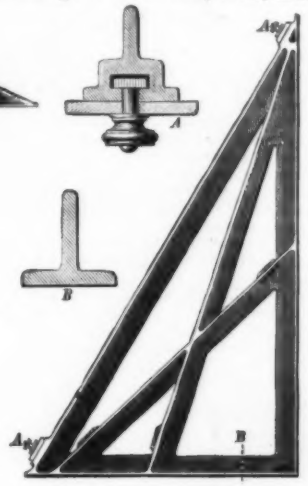


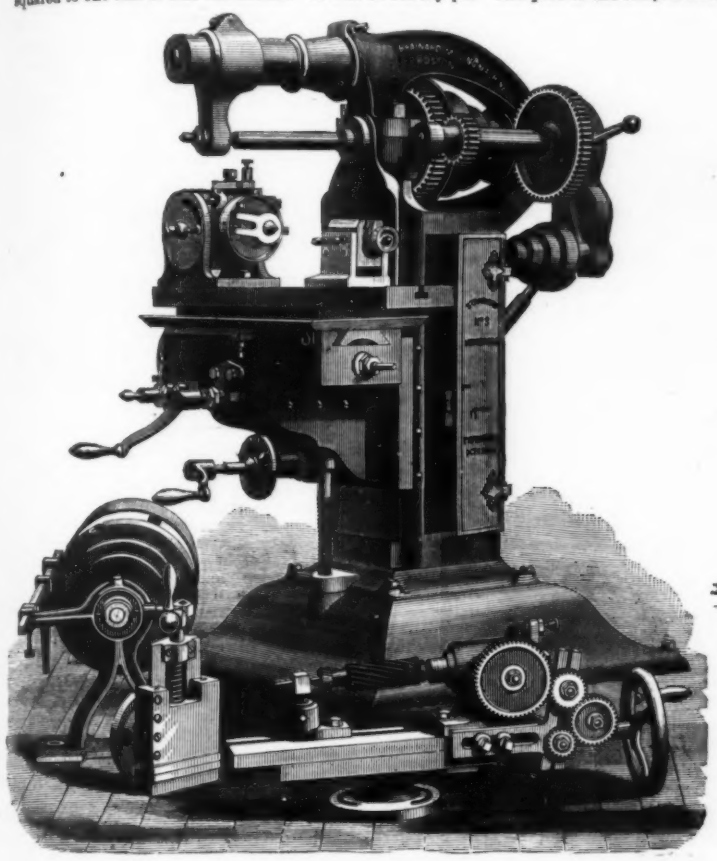

FIG. 5.

silver piece lies safely hidden away between the side of the key and the side of the keyway in the strap: nor is this an isolated instance of bad workmanship on this engine. There are split cotters driven home, but not split open at the ends, as they should be; and the pin connecting the slide-spindle to the rocker arm shows a great want of truth somewhere, since the inside head of the bolt is a fit on one side, while on the other it is gaping wide open; this remark applies equally as well to the washer on the crank-pin of the forward coupled wheel. These are defects we should scarcely expect to find in an exhibited engine, even though made by apprentices. Another of the locomotives exhibited by a prominent firm has the cross-head keyed to the piston-rod all out of line and truth, which it is sincerely to be hoped was done by an inexperienced apprentice, since it is discreditable to a high degree.

## THE BRAINARD MILLING MACHINE COMPANY'S EXHIBIT AT THE CENTENNIAL EXPOSITION.

THE milling machine, while acknowledged to be a great labor-saving invention, and capable of producing with accuracy forms so intricate and irregular that their duplication to a standard form and size is impracticable, has not, so far, assumed its proper place in the ordinary machine-shop for use on general work. In lathe and planer work the truth and correctness, both in form and size, of the work, depend upon the skill of the operator. In the milling machine those elements are, after the machine is once set, assured. It is self-evident, then, that there is an excellent field in the ordinary machine shop for a milling machine, providing it is in design and scope fitted for general rather than for special work. Of the origin of the milling machine we have no certain information; but the writer well remembers one in use in a railway shop as early as 1849, and it was not, then, by any means a new machine. It was used for milling nuts. It was provided with a milling tool precisely the same in form as those at present in use, and with a notch dial-plate. It was self-acting, and was operated by a boy, who turned and shaped nuts by contract, the pieces being 6 cents per dozen for turning and milling all nuts from ¼ in. up to 1 in. Of milling machines for general use there have been introduced but very few. A very successful one was built by F. O. Degener, the inventor of the Liberty Printing Press. It was made for his own use, and was employed for connecting rods, platen frames, links, levers, and, in fact, for any purpose requiring flat or parallel faces, and hence took the place of the ordinary planing machine, doing its work rapidly and well. This machine, however, was never duplicated. Brown & Sharp, of Providence, R. I., have for some years made a Universal Milling Machine, which has achieved a great success and a wide reputation. In the present article we describe the Brainard Milling Machine, ten sizes of which are exhibited at the Centennial. Of these we select for illustration the one known as the "Standard Universal," of which five sizes are entered, weighing from 525 lbs. to two tons, taking in work from 7 to 24 inches high, and having a feed from 9 to 36 inches, according to the size of the machine. That illustrated in our engraving is a size sufficiently heavy and powerful for moderately severe work, and yet is not unhandy for light work or for the use of small cutters. The frame of the machine consists of a square standard, with a wide-spreading base, and carries upon the top the driving and feed gear. The head is full-back geared like an engine lathe, the cone steps being made for a 2¼-inch belt. Over the bearings of the main spindle or arbor is sprung an arch, which braces the upper part of the machine and supports a projecting arm which carries a yoke, which, with its appendages, in turn supports the outer end of the mill or cutter spindle. This support is a matter of great importance, for without it the efficiency of the milling machine is confined to the use of cutters standing within a very few inches of the cutter spindle journal. With an outer steadying bearing, as in this machine, cutters of considerable size and at a maximum distance apart or from the cutter spindle bearings may be employed. In certain cases, however, the outer supporting arm

can be swung out of the way, leaving the arch still in place. The front of the frame of the machine is provided with slides to receive a strong knee, which is gibbed to the slides and which is operated perpendicularly by the screw, actuated by bevel-gears and the crank-handle shown. Upon the knee is mounted a carriage having a crosswise motion of five inches; and upon the carriage is mounted the table **T**, slotted both lengthwise and crosswise, the slots being all milled to gauge, and made parallel or square to the face of the machine. The table is provided with an oil channel which runs completely around it. The automatic feed which is connected with the table can also be worked by hand from either end of the latter, using for the purpose the cranks shown upon the elevating and cross-feed screws; the ends of all these screws are squared to one size to suit the cranks. It will be readily perceived that these three motions afford facility of adjustment either laterally or for height, the operator in either case merely using the crank-handles. The adjustment vertically can be gauged to $\frac{1}{1000}$ inch by means of the dial and pointer shown beneath the table and in front of the machine, and which is connected to the gearing. The feed-gear consists of a train of covered cut wheels, hanging from a point central from the main arbor and swinging freely about the centre. The lower wheel is keyed to the same shaft as the upper feed-cone. The other feed-cone is keyed to a shaft upon which is a hardened steel worm, which meshes into a worm-gear, also of hardened steel, and secured directly upon the feed-screw. The two feed-cones are connected and held apart by a coupling arm, made in two parts, so that by the turn of a hand nut the cones are forced apart and the feed-belt tightened without being unlaced; and this is an excellent arrangement. The knee, carriage, or work-table can be moved to their extreme ranges, whatever their position may be, without disturbing the feed-gear.



THE INTERNATIONAL EXHIBITION.—THE BRAINARD MILLING MACHINE.

The feed-worm is held in mesh by a latch, and can be dropped at any desired point by an adjustable dog.

The column is upon the plan generally termed box framed—that is, it is hollow, and the interior contains shelves affording closet room for arbors, cutters, etc.

The main arbor is 4 inches in diameter at its largest part, and 2 inches at the rear end, with a $\frac{9}{16}$-inch hole running through its entire length, and is provided with a screw at its front end, to receive a chuck. Thus far the machine is complete in itself, is simple and substantial, and we will now describe the various attachments by which the universal application is attained. The first of these is a universal head, which is shown upon the table, and an enlarged view of which is shown in Fig. 2, mounted on a long table. It can be used directly upon the work table if desired, the long or extra table being provided for use when very long work is to be finished upon centres. This head consists of a strong iron block swinging upon steel trunnions between two upright sides, and adjustable to any angle from the horizontal to the perpendicular. On one of the sides is a scale of 90 degrees, and the swinging block is set to any position, and locked by a set screw upon either side. Through the length of the block runs a hollow steel spindle, which carries a dial and a worm-gear; a crank operated at either side rotates a worm engaging with this gear. By setting the pointer to the proper circle of holes, spur, bevel, or spiral gears may be cut, and mills or cutters of almost any shape may be finished upon it. By removing the spindle and dog, a chuck may be used upon the spindle, and upon this chuck may be held any work that can not conveniently be finished either upon centres or upon a mill arbor. Thus nuts, bolts, set-screw heads, taps, reamers, and a multitude of jobs can be readily milled.

The back centre is, in our engraving, shown out of line; this part of the tool, however, can be depressed in a straight line or set to any desired angle, the object being to keep the centres in a line when finishing taper work.

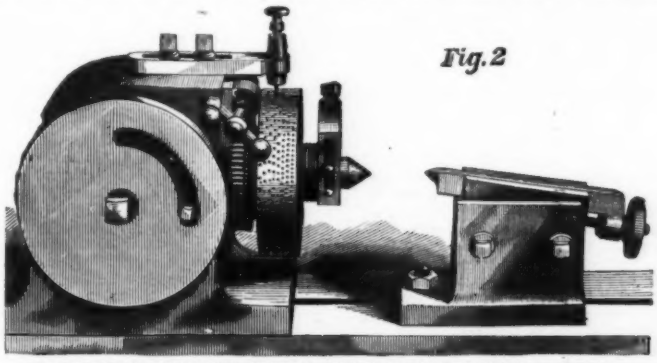


*Fig.2*

THE INTERNATIONAL EXHIBITION.—THE BRAINARD MILLING MACHINE.

At the base of the machine is shown another appliance, in the shape of a rotary vise, for use on the work table; this is held to the table by two bolts, and can be rotated 90 degrees.

The last attachment is the spiral cutting device, one form of which is also shown lying at the base of the machine.

It is often necessary to use cutters of considerable length. If the teeth of such cutters were straight, so that each tooth was alternately cutting along its entire length and suddenly relieved, the strain upon the mill arbor would be intermittent and the spring due to the cut would lift the arbor, leaving a wave mark upon the work, such as we often see upon the edges of planed as well as milled work. To obviate this difficulty, the teeth of such cutters are made spiral, so that the teeth are at all times cutting and leaving the work, and each tooth makes a shaving cut, requiring the employment of less power and producing a smoother cut. To produce these spiral cutters is one of the duties of the attachment we have referred to. The means by which this is accomplished is by rotating the blank while the cutter is cutting out the grooves, and thus forming the teeth. The device is actuated by the hand wheel which is keyed to the screw that imparts forward motion to the blank. The screw has also secured to it a worm operating a train of gearing, which rotates the blank while it is being fed forward, the amount of rotation bearing a fixed relation to the forward motion, so that all the teeth are cut parallel one to the other. The pitch to be given to the teeth is governed by the gears upon the side of the device, as also is the change from a right to a left spiral, the change gear being operated after the manner of that of a screw-cutting lathe. All the attachments are complete in themselves, and are interchangeable among all various machines of similar design, unless lighter attachments are desired. The object of this is that in shops where a number of milling machines are in use, and in which not much spiral cutting is performed, one attachment will suffice. One of these attachments is shown in operation at the Centennial, cutting a spiral groove on a conical blank 9 inches long. To show the stiffness of the machine and the clearness of the cut, this cone was first cut up with finished right-hand spiral grooves, and the self-acting feed-gear was then set for left-hand spirals, which were cut over and crossing the right-hand ones. This job was very well done, the edges giving no sign of a wave, but being even, clean and regular to a degree. The workmanship on the machine is well executed, the bearings are ample, and the general design makes it easy to operate.

## SHIPS' DAVITS.

THE accompanying illustration shows the arrangement of boat davits adopted on board the vessels of the American Steamship Company. The davits *a* are of round iron bent to the form shown, and hinged to brackets *b* on the deck. Each davit passes through a slot in a horizontal guide *c*, attached to suitable standards, and connected with the hand-rail of the ship. The boat is slung from eyes in the head of the davits by suitable tackle, and is supported upon the standards by blocks *d*. These blocks are hinged to the standards, and the davits are kept in the ordinary position by a key and pin passing through the slot. When it is desired to lower a boat the pin and key are removed, the supporting blocks thrown over on their hinges, and the davits fall forward, throwing the boat clear of the ship's side. It can then be lowered by the tackle. The drawing also shows the form and position on board of the sheet-iron rafts which these vessels all carry. The rafts are stowed under the boats, the whole being very compactly arranged, but always ready for an emergency.—*Engineering*.

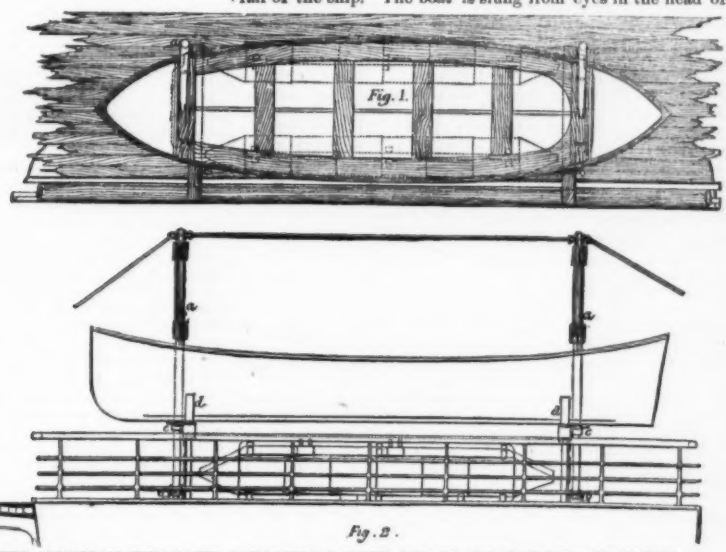


*Fig. 1.*



*Fig. 2.*

THE AMERICAN STEAMSHIP COMPANY'S DAVITS AND BOAT-LOWERING APPARATUS.

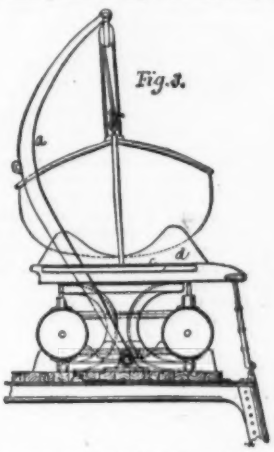
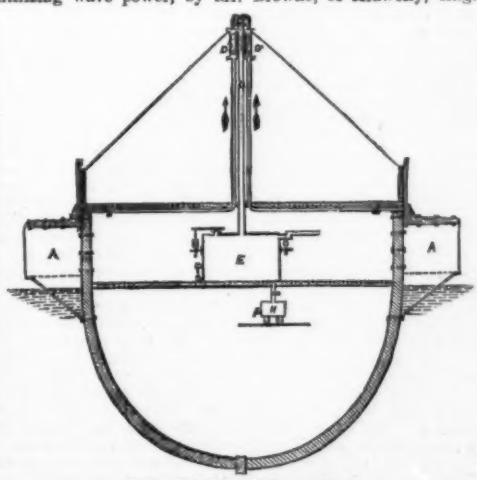


*Fig. 3.*

## WAVE POWER.

THE accompanying sketch illustrates a curious method of utilizing wave power, by Mr. Browne, of Kidwelly, Eng.,




NEW WAVE-POWER MOTOR

The *modus operandi* of the invention is as follows: Chambers A A are fitted on the outside of a ship, which chambers are open at bottom, but closed at top, except a pipe connected

with an air reservoir placed on board the vessel; in this connection-pipe there is a valve, which allows the passage of air from the chambers into an air reservoir E, but which prevents its return, and there is also in this connection-pipe a provision for preventing water passing with the air into the air reservoir, but should water by any chance get into the air reservoir, it can be drawn off at H. The air is forced into these chambers by the rolling of the ship, and the compressed air can be used for pumping, etc. It must be understood that the compression results not from the difference of head within and without the chamber, but from the inertia of the water, which acts almost as an immovable piston in the air chambers, when the ship rolls suddenly; in this way a much greater pressure can be obtained than that due to difference of head.—*The Engineer.*

## VETERINARY SURGERY AT THE EXHIBITION.

IN the Agricultural Building, at letter A, No. 24, J. W. Gadsden has an elaborate and highly instructive exhibit of specimens showing the anatomy, age, and disease of the horse; also the medicines and instruments used in the treatment of this most valuable member of the brute creation.

His exhibit consists of *one hundred and sixty* different articles, which naturally divide themselves into three distinct classes, namely, that illustrating the anatomy or structure of the horse, that having reference to the diseases to which the animal is subject, and, finally, their cure and treatment. Each of these subjects is illustrated in a skilful manner, either by cuts, diagrams, plaster casts, skeletons or bones.

The section devoted to equine diseases is very fully treated by cuts, diagrams, and plates, which even the novice in horse surgery will be able to take in at a glance.

## ELECTRIC MUSICAL INSTRUMENTS AT THE EXHIBITION.

THE Musical Department of the Philadelphia Exhibition is very full and attractive, but the many curious and novel instruments contained therein seem hitherto to have escaped the attention of the hosts of voluminous descriptive writers who have done the rest of the show to the last dot. A correspondent of the *Evening Post* of this city, in a letter recently published by that paper, gives some interesting information concerning this subject, from which we extract the following account of some instruments which are operated by electricity.

In the north gallery of the Main Exhibition Building is erected the noble church organ of Mr. Hilborne Roosevelt, of New York, and before it, suspended from the roof by two slender ropes, hangs a complete electric organ, while at the top of the English tower stands the Electric Echo organ, connected with the great organ by about 250 feet of wire cable. The electric suspended organ, which is 20 feet in front of the gallery, is also connected with a cable of insulated wires inserted in the slender rope by which it hangs. The wind is supplied to the principal part of the instrument by two of Jaques's improved brass hydraulic engines, which are seen in operation directly under the organ gallery.

The hanging organ has its own bellows attached to it, worked by a Union electric motor. This engine is about the size of a quart measure, and is operated by four cups of Bunsen's battery. This little organ, complete in all its parts, all of which are exposed to view, presents a novel and attractive appearance, particularly the pipes themselves, which are those of a traverse flute, having a most exquisite tone. These pipes are made to respond to the performer's touch by a Leclanche battery. The organ, which is elevated 250 feet above the performer, has similar appliances, and contains a vox humana stop, a gentle-toned flute, and a tremulant. Being enclosed in a swell box it is intended to produce the effect of a chorus of singers at a great distance. By the aid of electric, pneumatic, and tubular actions, the key, pedal, and draw-stop actions are made extremely light, and also prompt, so that the player can with little effort perform complex passages at a very high rate of speed. A new device is also here exhibited for the first time, by which the player before he begins may select six groups of stops, any one of which, though it may work an entire change over the whole instrument, can be opened by simply pressing down a corresponding composition pedal.

In the Horticultural Hall will be found a pipe organ with an electric action, which, as it contains also drums, cymbals, etc., is styled an electro-magnetic orchestra. Externally it appears as an ordinary church organ, but without the ordinary keys, pedals, draw-stops, etc. Near by stands an ordinary four-legged table, beneath the top of which is found a keyboard, and underneath a coil of rope that contains insulated wires. This table may be moved a long distance from the organ and placed in any position with reference to it, and yet control all the speaking pipes, etc. But the most extraordinary point to be noticed is that the instrument itself plays whatever is required from notes. It reads automatically the music sheets that are placed upon it. It is readily perceived that if the musical characters were printed in metallic or conducting marks, the electricity would distinguish between these and the non-conducting surface of the blank part of the paper. To save the necessity of setting up such costly type and going to press to obtain copies, the paper is simply perforated and a metallic plate placed under it. This perforated paper is sold at prices varying from fifty cents to one dollar per yard, whether for fugues and symphonies, or dance music, national airs, etc.; and a copy of "Yankee Doodle" with metallic notes may be obtained in the hall for five cents. The music is placed on the organ rolled up, and is unrolled gradually as it passes under a row of charged feelers or "readers," whose office it is to distinguish between the notes; after which it is rolled up again. The music itself is marked in the centre of the paper, and on either side are the notes or perforations, as the case may be, that cause the requisite changes to be made in the stops, varying the power, quality, and combinations of tone to produce the desired effect at each particular instant. It should be observed that the mechanical effect of ordinary barrel-organ music is not so readily perceived here, for the various modifications of speed, etc., that performers habitually make, may be so readily imitated, that any one desiring the instrument to give some particular shade of expression to any one passage, or even single note, may do so readily. *Staccato* passages may be converted into *legato* by making the perforations a trifle larger, and, *vice versa*, parts given to the flutes may be played by the clarinet or other instruments as desired, the drums may be made more or less vigorous in action, and the quickness of the strokes, obtained by a rapidly intermittent circuit-breaker, may be increased or diminished. The force of wind may be controlled with equal ease. If, in the case of dance music, a variation in speed is required, it is simply necessary to touch the "fly" which is made to act as governor. All trills, shakes, and arpeggios are given with considerable clearness of definition. The slightest mark or perforation will at the right moment of time send an electric current through the proper wire, as through a nerve, and will induce the corresponding magnet in the instrument instantly to give, like a muscle, the exact touch designed. The inventors assert that they are prepared to supply instruments of all sizes and in various styles, and give full priced lists with confidence. It is noteworthy that in the instrument exhibited the mechanism works noiselessly. No wind is lost in escaping puffs or power lost in friction.—*Journal of the Telegraph.*

## THE VICTORIA DOCK EXTENSION.

### A REMARKABLE ENGINEERING WORK.

THE members and associates of the Society of Engineers, London, lately paid a visit to the works of the Victoria Dock Extension, in course of execution for the directors of the London and St. Katherine Dock Company, from plans by Mr. A. M. Rendel, M.A., engineer, by Messrs. Lucas & Aird, contractors. The party was received at the Custom-house station by Mr. A. C. Andros, the resident engineer, who escorted the visitors over the works, courteously explaining each detail and feature of the work. The Victoria Dock, as now formed, is little more than a mile long and 800 feet wide; the "extension" will be 1¾ miles in length, 540 ft. wide throughout at the surface, and 450 feet at the base, with a lock at the further or eastern extremity. The water will be 30 ft. in depth at the sill, a considerable advance on the present one, which will be thrown into it on completion. The dock will not only be doubled in capacity, but what is perhaps of even greater importance, an entrance will be afforded in Galliot Reach, thus avoiding 3½ miles of the most difficult navigation of the Thames, and decreasing the "block" at Blackwall. In order to carry out this gigantic project it has been necessary to divert the North Woolwich line, the Manor road from that place to West Ham, and various sewer, gas, and water pipes, all of which cross the strip of marsh land to be added to the docks. The site is a level marshy area, 7 ft. below Trinity high-water mark, liable to flooding at extraordinary tides; the landward side of the extension will be faced by a concrete wall, forming a continuous quay 7 ft. above high-water mark and 2 ft. higher than the present dock wharfage, which has suffered from inroads of some of the highest tides; the river side will be defended by a bank, with a "bench" half way up. The contract has been taken at half a million, but this will be greatly exceeded. Operations were commenced in November last, and are to be completed in 40 months; at present the works are in a very forward state. About 3,000,000 cubic yards of earth are to be removed from the site. An extension of the docks was anticipated by their projector, Mr. Eidder, and he provided a stout dam of earthwork at the east end. To this the visitors were first conducted, and it was explained by Mr. Andros that a huge safety wall is being constructed to the east of it to protect the works against the possibility of a flooding during their progress. Between these walls a swing-bridge is being constructed on foundations of brickwork, laid when the docks were formed in 1854; it will have a span of 80 ft. on the square, and will carry a railway and a carriage way, connecting the towns of West Ham and Silvertown. When the extension works commenced the railway to North Woolwich ran through, just outside the old eastdam; it has been temporarily diverted further east, and when the works are finished it is to take a "sensation header" beneath the dock, descending at a gradient of 1 in 50, to a depth of 50 ft. below high-water mark, and rising at a similar gradient on the further side. To this spot the members proceeded. The work is being carried out by means of a cutting, to be afterwards covered in by a tunnel of about 600 yards in length. In case of the occurrence of a block in the tunnel, it will be possible to carry on the railway company's traffic over the swing-bridge referred to above. The strata passed through here and throughout the works are gravel, clay, an extensive layer of peat, gravel, concreted oyster and other shells, clay and rock, which will form the bed of the tunnel. The works here at present take the form of a cutting 55 ft. wide, and of varying depth, constantly being increased by the navvies, who at this point work in "butty-gangs;" here and all over the work they are paid by the piece, and consequently no overlookers are needed. Engines are being substituted for horses in tipping the material, with good results. The enterprise of the contractors is displayed in the fact that the temporary works to support the sides of the cutting are formed by sheet piling, driven in by steam power, which, it was remarked by some visitors, was doubtless the cheapest in the end, and certainly the most free from risk. The members proceeded to a sumpt, by which the cuttings are kept free from water. This is one of the largest of the kind, being 40 ft. square and 50 ft. deep, and will be permanently occupied by a well and pumping apparatus to remove the water from the tunnel. At present the pump is occupied by two 18-in. pumps which deliver the contents to a second sumpt 30 ft. square and 56 ft. deep, to which the party proceeded. Here two 24-in. pumps, worked by a 40 horse-power engine, were engaged at the lowest possible speed in transferring about 1200 gallons of water per minute to the Victoria Docks "cut," from which it is discharged at ebb tide into the Thames at Galliot Reach. Extra engines, boilers, and pumps are on the works in readiness for use or in any emergency, so that an enormous reserve of force is provided against contingencies. All engines were made by Messrs. Clayton & Shuttleworth, of Lincoln; the pumps by Messrs. Sampson, of Pimlico. They have thus far worked without a hitch. After partaking of refreshments, hospitably provided in the contractors' office, and examining some of the plans, the members of the party proceeded to view the excavations proper for the dock. This, owing to the peaty nature of the soil, is a very simple matter, the earth being removed from the centre and utilized for forming the banks and quays. A great part of the labor is being performed by navvies, with the aid of a network of temporary lines and three sizes of locomotives, but a steam excavator is under trial, whose operations were watched by the party with much interest. Built according to Messrs. Rushton's & Proctor's patent by that firm at a cost of about £1000, it is said to be a manifest improvement on the American excavators. It rapidly scooped out sections of the marsh 10 ft. thick, and transferred them to wagons which ran to and fro on rails upon either side. Its performances were stated to average 450 yards of earth per day, against a navvy's 20 or 22 yards, but at present its work is, at least, as costly as hand excavation. It has the advantage of rendering the contractors more independent of the navvies and their strikes. On another portion of the work the visitors saw the piles driven for a land dredger in course of construction by Messrs. Hunter & English, from plans by Mr. Aird. It is understood the ground will be scooped out by a series of revolving buckets working on an endless chain, on the principle of the river mud machine, and which will, it is hoped, remove 700 yards per day. At present about 33,000 cubic yards of earth are being removed every week from the docks, and efforts are being made to increase this to 40,000 yards per week. It was stated that the bottom of the dock is not to be puddled, for recent experience in dock-cutting has shown it to be unnecessary, as it will stanch itself in a very short time by the deposit of mud. The works for the walls were next examined. The quays, which, as we have already remarked, will be 14 ft. above the marsh level, and will extend along the whole of the inland side of the dock, will be faced with a mass of concrete mixed in the proportion of 7 to 1, gravel and best Portland cement being the only materials. This frontage of concrete will be from 6 ft. to 16 ft. in width, and extend to a depth of 35 ft.; and a batter of 1 to 27 is allowed. No material is used for facing the work, which, as completed, has a smooth and firm surface, capable of resisting great pressure. The concrete is mixed *in situ*, in ordinary wooden frames; the gravel is riddled before use to remove the sand, and the resultant concrete is tested at every point, by a pressure of 500 lbs. upon a block 2¼ in. in cube sectional area.

The party were next conveyed by a special train through the works. The Manor road from West Ham to North Woolwich ferry crosses the site near the new mouth, and is to be carried across it by a swing-bridge 24 ft. wide and 90 ft. in square span at the height of 12 ft. above the high-water mark. The small portion of the dock thus separated will form a basin. Near it is a sumpt 25 ft. square and 30 ft. deep, from which the water that forces its way in under the river bank is being removed by two 24-in. pumps worked by forty horse-power engines. To the east of this is to be the lock, 800 ft. long and 80 ft. wide, closed by three pair of gates. The sides will be formed of concrete faced with Medway bricks; the quoins and sluice stones are to be of granite, but the coping will be of extra rich concrete blocks. The visit was concluded by an inspection of the coffer dam at the mouth of the lock. This encloses a triangular space about 100 feet wide, and is being formed by two rows of piles driven by six steam engines. Two jetties, each 180 feet in length, will extend into the river on either side of the lock entrance.—*Building News.*

## THE WOOLWICH SUBWAY, LONDON.

ALTHOUGH frequent communication is maintained between the Essex and Kentish shores of the River Thames at Woolwich by means of steam ferry-boats, there are times when the boats can not ply, and when, consequently, access to either shore has to be obtained by other means. These means are small rowing boats, and at night and during foggy weather, when the ferry-boats are not running, persons requiring to cross the river are obliged to have recourse to the smaller and frailer craft. This method of crossing, however, under those conditions is exceedingly perilous, and has more than once resulted in accidents which have been attended with loss of life. In order, therefore, to obviate such calamities in the future, as well as to afford the means of uninterrupted and direct passenger communication between North and South Woolwich, it was determined a few years since to apply to Parliament for powers to construct a subway under the Thames between those points.

The subway will commence on the north bank of the river, at a point close by the North Woolwich station of the Great Eastern Railway. In a vacant piece of land adjoining the station there will be a shaft 24 ft. diameter and 20 ft. deep, at the bottom of which the subway will commence. Passengers through the subway will have to ascend and descend this shaft, although it is intended eventually to afford direct access from the subway to the railway station by means of an inclined road. From the bottom of the shaft the subway will have a descending gradient of 1 in 8 for 444 ft., at which point the footway will be 74 ft. below Trinity high-water level. The subway will then rise on a gradient of 1 in 140 for 860 ft., and then 1 in 8 for 489 ft., at which point the footway will be 20 ft. below the surface of the ground at Bell Water-gate, South Woolwich. It is at present proposed to have a curved and partly covered approach-road, leading from the end of the subway into High street, Woolwich, which runs close by Bell Watergate. The total length of the subway is 1793 ft., or rather more than the third of a mile. The reason for carrying it at such a depth below the river is that the Conservators of the Thames required that the top of the subway shall be 60 ft. below Trinity high-water for a length of 700 ft. in the middle of the river. Hence the inclines at each end of the way.

The subway will be formed of a tube having an internal diameter of 9 ft. when finished. This tube will be composed of cast-iron segments or rings, 3 ft. in length, and bolted together through flanges on the inside. There will be horizontal as well as vertical joints, and the panels between the flanges will be filled in with white glazed bricks, which will reflect the gaslight within the tube, and will tend to render the passage through it agreeable. The ventilation of the subway will be effected by means of a perforated tube, placed along the top of the way, and opening to the outer atmosphere at each end. As the subway will at all times be lighted by gas, the products of combustion will pass away through the perforated tube, and will carry the foul air away with them. The floor of the subway will be 7 ft. wide, and will consist of asphalte, laid on a bed of concrete. At the foot of each incline will be a catch-pit for drainage water, and a small pump for raising it to the surface. The engineers of the Woolwich Subway Company are Messrs. Gilbert & Greathead, from whose designs the works are being carried out. The contractors are Messrs. Sharpe & Poole; and the estimated cost is £75,000. The toll to be taken under the Act is 1d. per passenger, weekly tickets at reduced rates.

At the present time trial borings are being made on the north side of the river, and they have reached a depth of 40 ft. from the surface, through peat and clay into the gravel. On the south side the borings disclose chalk, and the nature of the intermediate stratification is now being investigated. The Geological Survey maps show a fault to occur near the river at this point, and it is expected that the subway will at some point beneath the river cross the fault and pass from the gravel formation into that of the chalk. It will thus be seen that some special arrangement will be required in tunnelling for the subway to meet the difficulty of working in loose water-bearing strata. The method of construction to be employed has been designed by Mr. Greathead, and it meets the difficulty and danger of working in such a soil, which involves the necessity of exposing a surface of wet, soft, or loose material, and at the same time taking away all support from it by pumping out the water which it contains. The mode of procedure forms an interesting engineering feature in the construction. For the purpose of excavating the material and of building up the iron tube, a shield or cap is employed, lapping over and enclosing the advanced end of the tube, much in the same way as in some cases a cap covers the end of a telescope. This cap is pushed forward by hydraulic rams butting against the completed portion of the tube as the excavation is carried on in front. In the face, or end, of the shield are several openings, through which a

strong current of water is ejected from a tank in the interior of the shield. At the bottom of the face is a larger opening, through which the water returns and is carried back through a pipe to the tank at the rear of the shield. The water is circulated with sufficient force and has sufficient velocity in the return-pipe to carry with it the sand and gravel, which will be deposited in the tank from which the water was drawn. In the bottom of the tank are closed outlets, from which the débris can be run off into wagons and removed at intervals. In order to assist the disintegration of the soil in front of the shield, long rods or chisels are passed through stuffing-boxes in the face, and are worked by the men from the inside of the shield. These chisels can be worked at various angles and in all directions, so that the soil is thoroughly loosened in front. The circulation of the current of water is established and maintained by means of a rotary pump worked by compressed air.

It is possible that large boulders or other obstructions may be met in the course of working, in which case the ordinary air-lock can be employed, the shield being so arranged as to admit of this. In this case a stream of highly compressed air is supplied to the shield, which forces back the water, access to and egress from the shield being afforded by an intermediate chamber with double doors. As the excavation advances the shield is caused to follow it up by means of hydraulic rams capable of exerting a pressure greatly in excess of that of the water on the face of the shield and of the resistance due to friction. The segments composing the tube are lifted into position by a mechanical appliance in the interior of the shield. The tanks and in fact the whole of the machinery will travel upon rails, and will be drawn forward by the shield, to which they are attached.

Such are the general features of what will be the third tunnel under the Thames, and which, it is expected, will be completed about the middle of next year, and which can not fail to prove of considerable advantage to the localities it is intended to serve.

## SPRING MOTORS.

### STEEL AND AUSTIN'S SPRING-PROPELLED CAR.

THE invention of Robert Steel and Samuel Austin, of Philadelphia, Pa., is as follows:

Fig. 1 is a plan view of the under side of the platform of a city passenger car. Fig. 2 is a vertical longitudinal section of

*Fig. 1.*

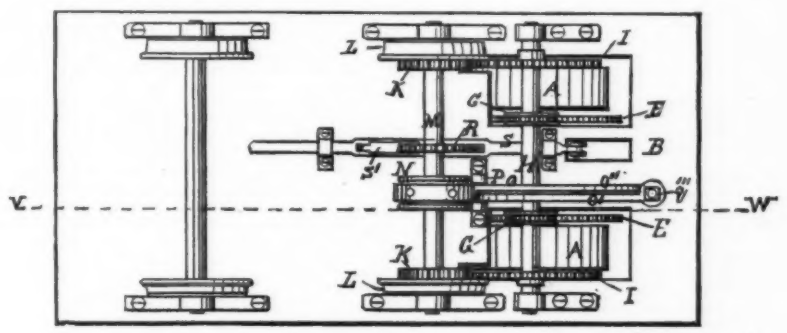



*Fig. 2.*

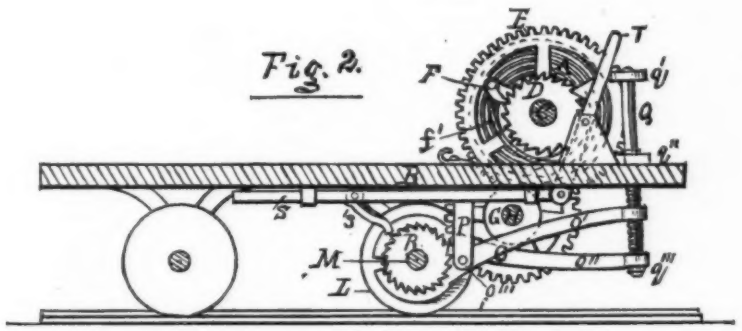
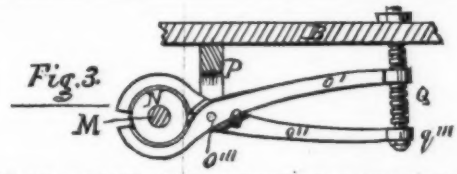



*Fig. 3.*




SPRING MOTORS.—STEEL AND AUSTIN'S CAR PROPELLER.

the same above the dotted line *v w* of Fig. 1. Fig. 3 is a side view of the brake as when in action as such, in connection with the cylinder on the axle, and with a section of the platform of the vehicle.

A A are two coiled, flat, spring-steel springs, one end of each of which is firmly secured to the platform B, and the other end firmly fixed to the shaft C, around which it winds, the said shaft rotating in suitably strong bearings (not shown in the drawings), which are firmly secured on the platform B. Suitable slots or openings are made through the said platform for the reception of the said springs. D (see Fig. 2) is one of two ratchet-wheels which are firmly fixed to the shaft C, one near each spring A A, and between each pair of the said ratchet-wheels and springs one of two main cog-wheels, E E, is secured, so as to turn around on the shaft C. Attached to the ratchet-wheel side of each of the cog-wheels E E, a pawl F, and its actuating spring *f*, are arranged to act on the said wheel E, so as to prevent it from turning on its shaft, except when the springs are being wound up. One end of the shaft C projects sufficiently to admit of the attachment, through intermediate gearing, of suitable steam or horse power, to wind up the springs A A at the station from which the vehicle is to set out upon its circuit. Each of the large cog-wheels E E gear into respective pinions or smaller wheels G G, which are fixed on a rotary shaft, H, and near each end of said shaft H a large cog-wheel, I, is fixed, and gears into one of two smaller cog-wheels, K K, which are rigidly fixed to the respective track-wheels L L, which are fixed on the axle M of the vehicle. Near the mid-length of the axle M a cylinder, N (see Fig. 1), is fixed, and around this cylinder the clamping-jaws of the brake O are arranged. (See Figs. 2 and 3.) The said brake O consists of two crossing levers, O' O'', which have their connecting-fulcrum O''' secured through a stationary hanger, P, which is fixed to the under side of the platform B. The power ends of the levers of the said brake O extend forward into connection with a vertically arranged operating-shaft Q, which extends upward from said arms of the brake, through the platform B, into convenient reach of the attendant, and has a hand-wheel, *q'*, thereat, for giving leverage for rotating the same, and flanges *q''* to prevent undue longitudinal movements of the said shaft within the plate which holds it firmly in position in the platform. Below the said platform the shaft is screw-cut, and the upper power-arm O' traverses the threads of the screw when the shaft Q is being rotated. The lower end of the said shaft Q has a reduced portion, and consequently a shoulder. The reduced portion passes through the end of the lower power end of the break, and has a screw-nut, *q'''*, thereon, so fixed as to allow the end of lever-arm O'' to slip up and down, on the reduced portion, between the shoulder and the nut *q'''*, for the purpose of allowing the clamping end of said lever to rise a little from the face of the cylinder N when the said shaft Q is rotated to relax the gripe of the brake around the said cylinder. By rotating the shaft Q in the opposite direction the lower arm, O'', is supported by the nut *q'''*, and the upper arm is forced downward, and thus the clamping-jaws are caused to press upon the cylinder N and arrest the rotary motion of the axle M and track-wheels L L. For the purpose of giving an immediate start to the vehicle after each arrest by the action of the brake O, a strong ratchet-toothed wheel, R, is fixed (at any suitable point between the cylinder N and the track-wheel on that side) to the axle M; and a sliding bar, S, with a pawl, *s'*, attached thereto, is applied along the under side of the platform B, so as to pass directly over the ratchet-wheel R and cause the pawl *s'* to catch in the teeth of the said wheel R when the bar S is being drawn forward, and so also as to become disconnected from the wheel R when the said bar S is pushed fully backward. Motion is given to the bar S by the attendant by means of the hand-lever T. It will therefore be seen that by means of said starting devices a sudden or immediate movement in a forward direction may be given to the vehicle, should it at any time be required.

## HORTICULTURAL NOTES.

*Packing Grapes.*—A successful shipper gives the following as his method of picking and packing, when large boxes are used, and not the small fancy boxes, although the same general directions will apply to both: Gather the grapes only in dry weather, cutting the stalk with a sharp knife; remove carefully all defective berries from each bunch, taking special care not to rub off any of the bloom, as on this precaution depends greatly their appearance in market. A shallow hand-basket may be used to receive them. Carry them to the packing room tip the boxes with a blocking slightly towards you, and lay the bunches in one at a time carefully, so as to fit well together, in regular layers, making an even top without cutting bunches, and with stems under and concealed. This will require some skill and practice. They should stand several hours before the cover is placed on them, and the box should be full enough for the surface at the top to project an inch or more above the rim, so that when the cover is pressed down to its place, their elasticity may keep them compactly together without rattling in carrying. We have seen grapes utterly ruined by not being packed compactly to prevent rattling.

*Thinning Fruit.*—Additional facts come before us every year showing the importance of thinning fruit on the trees early in the season. E. Moody of Lockport stated some years ago that while the large handsome peaches on his thinned trees brought a dollar and a half per basket, the same sorts on crowded branches sold for only half a dollar. More recently Mr. Dyckman, of White Haven, has cited instances where his thinned crop readily brought $2.50 per basket, and unthinned only $1.25. There is less difference when the trees are young and bear large specimens, but as they become older and more productive, the difference becomes very distinct. But the increased price is not the only advantage. An overloaded tree is soon exhausted. A large orchardist in Ohio lost his 3000 trees by the cold of winter, after a very heavy crop; while trees which had not borne were uninjured. We had a fine plum orchard nearly ruined some years ago in the same way, after several very heavy and unthinned crops, resulting from a thorough destruction of the curculio. It is much easier to thin out poor specimens early, than to hand-pick all and then assort them.

*Cracking of the Doyenné.*—A correspondent of one of our exchanges has succeeded in raising this year fine and fair specimens of the White Doyenné pear, after many years of worthless fruit from cracking and black fungus. He ascribes this improvement wholly to alkaline applications, in shape of ashes and soap suds. We have had the finest, largest and fairest specimens of this pear the present season that we ever met with, but no alkali was applied, and the same favorable result has now occurred for two years in many localities all through the country, with no different treatment than before. Cultivators are apt to ascribe success to whatever remedy happens to precede natural or other causes.

*Setting Raspberries in Autumn.*—Purdy's *Fruit Recorder* gives the most successful planting of raspberries as in autumn, by the following mode: The young plants were carefully set, the roots well spread out, and the mellow earth which covered them beaten with the hoe over the plants to show where they were. As soon as the ground froze in winter, a wagon load of manure was driven over the plantation, and a shovelful placed on each beaten spot. Early in spring the whole surface was harrowed, which scattered the manure and mixed it with the soil. This mellowed the soil, and destroyed the weeds that were just ready to come up, leaving a clean surface till the young raspberries were half a foot high.

*Rose Slug.*—The *Gardener's Monthly* gives the following mixture to destroy or repel the rose slug: Add a tablespoonful of powdered white hellebore to two gallons of boiling water. Apply to the bush when cold, with a whisk broom in a fine spray, bending the tops over so as to reach the under surface of the leaves. One application is usually sufficient, and it is cheap, easy and effective. This is a good way to treat the currant worm.

*Raising Seedling Strawberries.*—Systematic skill is required in the production of new varieties with success. Amos Miller, of Carlisle, Pa., raised his seed on a ridge a quarter of a mile from any wild or cultivated plants. The pistillate Green Prolific was placed in the centre, and the staminate Jucunda planted in a circle around. From the cross thus obtained, the famous Springdale and Cumberland were produced. E. W. Durand, who has obtained some good and promising sorts, has raised no less than 50,000 seedlings in all. He produces about 2000 or 3000 yearly. The seeds are not planted till the following spring, but are washed out, dried, and placed in marked papers showing their parentage. The second year the most promising seedlings are selected, and the rest thrown out. This requires much experience and skill. Mr. D. thinks it of very great importance that the pairs producing the seed should be widely separated from all other plants—as practised by Mr. Miller already mentioned. Without this care, he thinks a man might go on for thousands of years and get nothing. He thinks also that large sorts are as good in flavor as small ones. But as large ones are often selected merely because they are large, without regard to flavor, it has led to the belief that they are essentially poor.

*Watermelons and Muskmelons.*—A rich sandy loam in a somewhat warm latitude is well known as best adapted to the successful growth of the watermelon; but we have seen them successfully grown nearly as far north as 43° north latitude, where the soil was a strong clayey loam. A wagon load of manure was placed in a heap, and covered half a foot thick with inverted turf. The object of this heap of manure and turf was to provide the drainage which a sandy soil gives, with a constant supply of sufficient moisture. Three or four rich spots were made in the covering on different sides to receive the seeds. This treatment resulted in an abundance of fine fruit. In a late number of the *London Garden*, a mode with one of these requisites is described as eminently successful for the muskmelon, in Southern England. A bed of decaying leaves, instead of stable manure, is made three feet high, a frame placed on the top, additional leaves trodden into the frame, and three inches of loam placed upon them. The melon roots run down into the leaves, and very large and fine melons are the result.

*Seed-Producing Hybrids.*—C. M. Hovey says that of all his hybrids and crosses of the strawberry, only one proved sterile. This was when a number of plants were hybridized with the Hautbois; none of the seedlings produced fruit. He cites many instances among ornamentals, showing that the opinion, sometimes held, that hybrids are sterile, is not supported by facts. *Rhododendron catawbiense* and *arboreum*, fertilized with each other, produce fertile seedlings; also several species of the *azalea*, with like results. The same result took place with different species of the lily and *pæonia*, and of several other plants on which the experiment was performed.

*Striking Cuttings—Easy Mode.*—The *Rural New Yorker* gives in substance the following method, which has been found remarkably easy: Take a flower pot about eight inches in diameter, invert a saucer within it large enough to rest against the sides half way down, or lower, which is better than using broken crocks or stones. This drainage is necessary where there is no bottom heat. Then fill to the brim with very coarse sifted sand. Place the pot in a strong light, and saturate the sand a few hours with water, providing a proper vessel for drainage. Make the cuttings from two to five inches long, retaining more leaves in autumn than earlier, but stripping them off nearly to the top, and insert them half an inch in depth, about twenty to the pot. New buds in time will show that roots are formed, when they are to be lifted out with a teaspoon, and set in small pots of rich sandy soil, avoiding clayey soil, which will become too hard. If too many leaves are left on the cutting, they will be likely to droop. September is a good time for this work.—*Cultivator and Country Gentleman.*

## THE FRENCH INTERNATIONAL EXPOSIITON OF 1878.

### THE PROPOSED MONSTER BALLOON.

THE well-known inventor of the steam injector, M. Henri Giffard, who of late years has devoted considerable attention to aeronautics, proposes to construct a balloon larger than any ever yet built, for exhibition at the World's Fair, to be held in Paris in 1878. The air ship will be strongly moored, and will make ascensions to the length of its cable, so as to afford visitors a magnificent view of the capital city and its environs. We take the accompanying engravings and description from *La Nature*.

The balloon will be made of sheets of linen and of india-rubber alternately superposed, covered with several coats of varnish, and painted white, so as to reflect the sun's rays. Its cubic contents will measure about 65,400 feet, and its diameter will be 109 feet. Two immense valves will be arranged: one at the summit, the other at the base of the globe. The first will be governed by the occupants of the car, and the second will open automatically when dilatation of the gas takes place. To join the gores of the fabric, which will weigh over 4 tons, 3½ miles of seams will be made. The aggregate length of the netting cords will be 19 miles, and their weight over 3 tons.

The car will have a gallery 50 feet in circumference for visitors, and the interior enclosed space will be occupied by the aeronauts who manage the balloon. Below the gallery a chamber is to be provided for guide ropes, ballast anchors, etc. Eight cables will moor the air ship to massive iron anchors imbedded in masonry. The car, when the balloon is on the earth, will be suspended in a huge conical apartment, and from the upper walls of the latter gangways will extend so as to allow easy access to its gallery. There will be sufficient room in the car to accommodate fifty people. The ascension cable is to be attached to the lower concentrating ring, as shown in the large engraving Fig. 1, and consists of a rope 10 inches in diameter. A number of small ropes are attached to the ring, and their ends are secured to a spring balance, to the other extremity of which the main cable is fastened. Dials on the faces of this instrument indicate the lifting force of the balloon.

The ground end of the cable is to be carried through a tunnel 150 feet long, and thence around a large cast-iron drum 6 feet in diameter, which is rotated to pull the balloon down by a 200 horse-power steam engine. The length of the cable will be 1760 feet, and the total ascensional force of the balloon over the weight of passengers and apparatus will be about 5 tons. The huge size of the aerostat, as well as the above-described arrangements, will be understood from Fig. 2. A is the balloon, and B is the size of a balloon of 32,000 cubic feet, and of the dimensions commonly employed to carry three or four people. N is the car, from which passes the cable, as already explained, to the engine *m*; *b* is the cable drum, and at *a* are the mooring anchors. It is proposed to establish all the apparatus in a circular enclosure, as represented in the plan Fig. 3. At E is the main entrance; *t*, tents for spectators; A is the balloon; and at H the hydrogen gas generators will be located. The position of this space relative to the general plan of the Exposition buildings is shown in Fig. 4. It will be observed that half of the structures are to be devoted to French productions, and that the foreign contributions are to be located together. The balloon enclosure is in the midst of the grand square, and near the bank of the Seine.

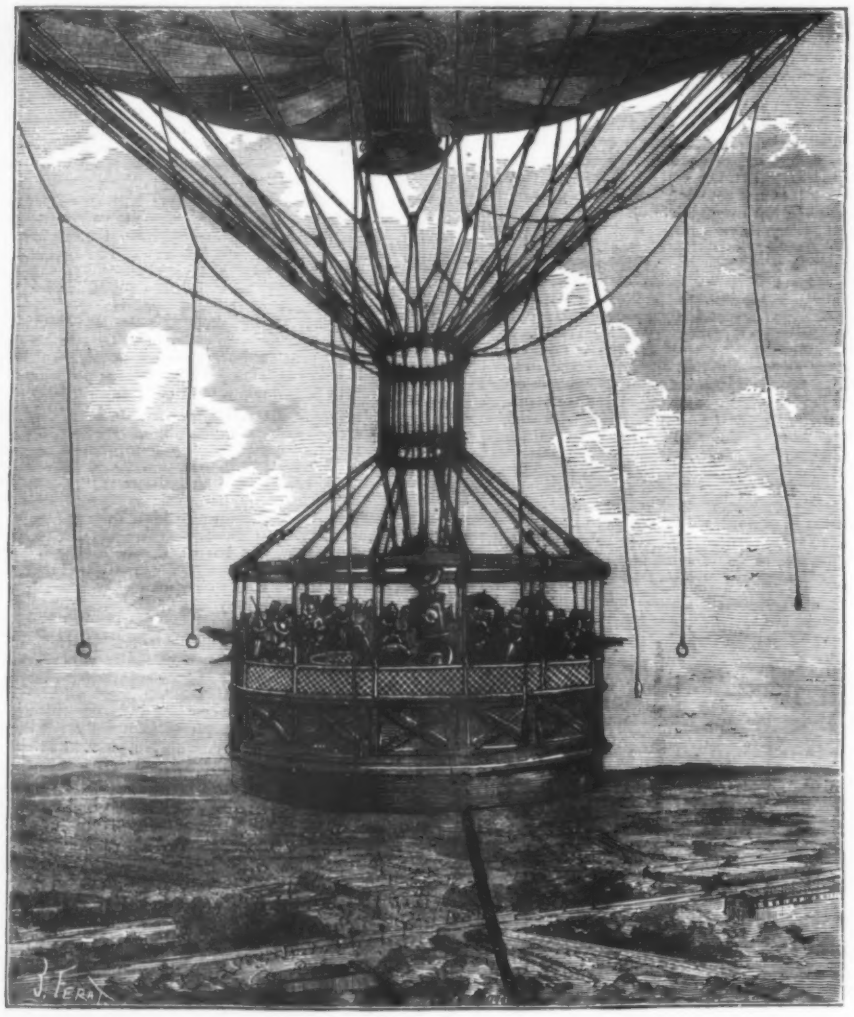


FIG. 1.—THE FRENCH INTERNATIONAL EXPOSITION OF 1878.—THE GREAT BALLOON NOW BEING CONSTRUCTED

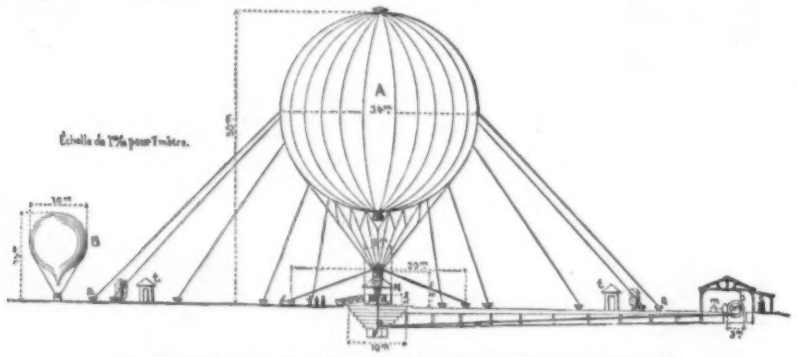



FIG. 2.—METHOD OF WORKING THE CABLE OF THE GREAT BALLOON.

## THE SCIENTIFIC LOAN APPARATUS EXPOSITION, LONDON.

### REGISTERING INSTRUMENTS.

A LARGE amount of inventive skill has of late years been devoted to the construction of new registering apparatus, by means of which physical phenomena, often of complicated and delicate nature, may be graphically recorded and thus rendered intelligible. At the Loan Collection of Scientific Apparatus lately on exhibition at the South Kensington Museum, London, recording instruments of the latest design were displayed in considerable variety. The characteristics of some of the various types of these devices are briefly pointed out in the following article, which we translate and condense from *La Nature*:

The most perfect registering devices are those which give the *curve* of a phenomenon—that is to say, which indicate on the paper or tablet, placed to receive the record, the successive phases and their respective durations of the occurrence. These are most often *direct* registers. The movement of a falling body, for instance, is governed by the laws of gravity. These laws are indicated by a curve which the body itself, in descending, causes to be traced on a cylinder turning about a vertical axis. Morin & Poncelet's apparatus is one of this description, and it perhaps really constitutes the basis of the graphic methods. The sciences of mechanics, physics, biology, and meteorology, which involve the study of the most varied movements, constantly employ the direct system of register, and glean data from the curves obtained.

The oscillations of vibrating rods, which Wheatstone rendered visible by placing at the extremities of a rod a small sphere of polished copper, are directly recorded by Koenig's

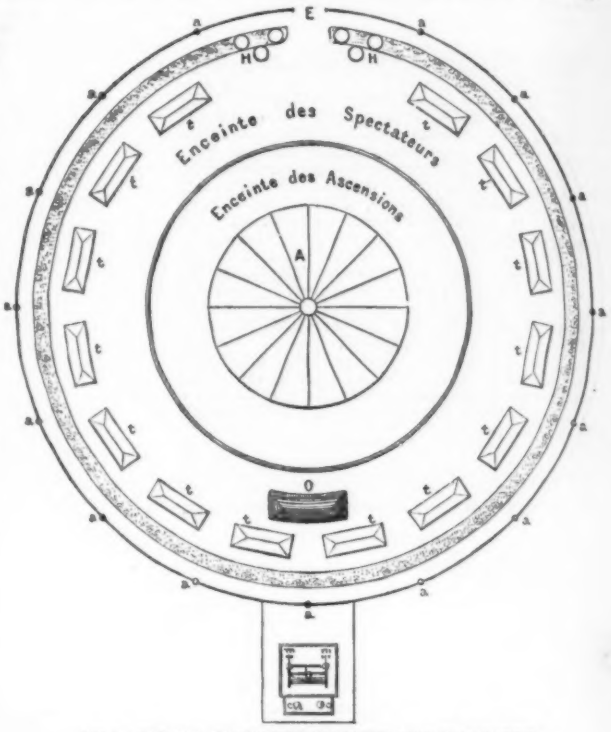



FIG. 3.—SPECIAL ENCLOSURE FOR THE GREAT BALLOON.

device of a stylus attached to the rod, which thus traces the movement under all conditions. An excellent idea of the formation in this manner of the most diverse figures, due to the combination of movements of rods vibrating in different directions, and of the inter-relation of perpendicular oscillations of equal or unequal frequence, can be obtained by examining the traces of Knoblauch's perpendicular apparatus, Slaby's ellipsograph, or Lissajoux's apparatus. In Fig. 1 is reproduced some simple records made by the last-mentioned machine. The first and topmost series represents one vertical vibration combined with one transverse vibration—in the relation of 1 to 1 or in acoustical unison. The second series shows the result of one vertical vibration combined with two transverse vibrations—relation of 1 to 2 or the acoustical octave. The third series indicates two vertical vibrations to

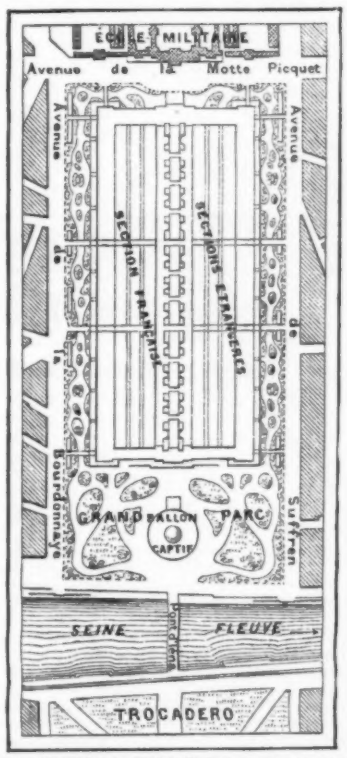



FIG. 4.—PLAN OF THE GROUNDS, FRENCH EXPOSITION OF 1878.

three transverse—the relation is therefore 2 to 3 or the acoustical fifth. The last series indicates the relation of 3 to 4 or the acoustical fourth.

Thomas Young obtained a record of the division of time by inscribing on a turning cylinder the isochronous oscillations of a vibrating rod carrying a light stylus. Latterly, however, chronography employs the direct inscription of the vibrations of the diapason, vibrations which the optical method of Lissajoux and the Koenig method of resultant sounds permit of being determined with exactness. These methods constitute a most valuable resource, both in point of certainty and simplicity.

The direct inscription of the movements of the mercury manometer by means of a float, which rises and falls with the level of the mercury in the long branch of a U manometer, is especially employed in physiology. Von Rotha's large registering apparatus admits of the study of the movements of liquids in the vessels of the human body, and among other curious facts has shown that for a single impulse the mercury column oscillates several times. The traces indicate the period of oscillation of the mercury, and show further that in the interpretation of curves thus obtained a correction is to be applied when the phenomena studied are not rapid, and when their variations numerically approximate said period of oscillation.

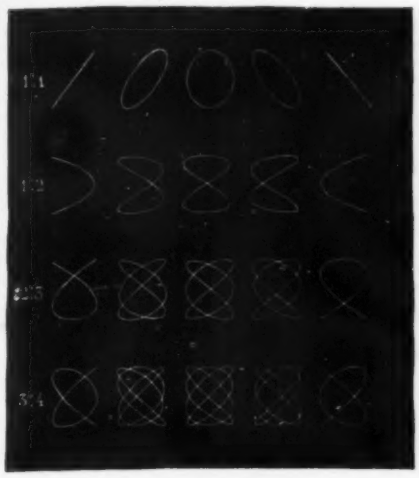


FIG. 1. REGISTERED VIBRATIONS.

The applications of the same method to meteorological studies are exhibited in several very delicate instruments. In one, combined in a small space, is an aneroid barometer in ten compartments; a metallic thermometer, consisting of ten zinc tubes and a registering cylinder, on which are inscribed the variations of atmospheric pressure and of temperature. The instrument designed for use on shipboard is the device of Professor Paugger, of Trieste. A small lever is attached to one of the zinc thermometer tubes, and inscribes on the cylinder, placed in the centre of the tubular system, the various dilatations and contractions of the metal produced by changes of temperature; the expansions and contractions of the ten aneroids due to barometric changes are likewise registered.

Another ingenious device is Elliott's pluviometer, in which all evaporation of water is prevented, and thus the quantity which has fallen in the shape of rain in a given period is accurately determined. The rain collected by a vase-shaped receptacle runs into a small cup which oscillates on a horizontal axis, each oscillation being determined by the entrance of and being proportional to a given quantity of water. A system of wheels is thus set in motion, and the curves of the movements are inscribed on a divided dial.

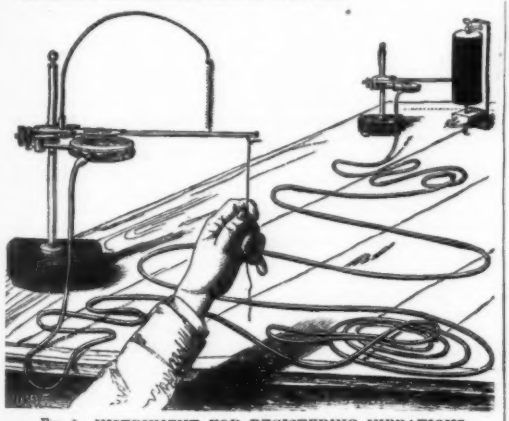


FIG. 2. INSTRUMENT FOR REGISTERING VIBRATIONS.

Fig. 2 represents an apparatus designed for transmitting movements over a considerable distance. The motion applied to the end of a lever is transmitted to a membrane, the compression and expansion of which generate a wave in the medium within the tube, and affect a similar device covered with membrane at the other end of the tube. The expansion and contraction of the second membrane cause a lever to inscribe a sinuous line on a rotating blackened cylinder. From this line the nature, etc., of the vibrations transmitted is determined.

## HISTORICAL FEATURES IN THE LOAN COLLECTION EXHIBITION, LONDON.

### THE EARLIEST MICROSCOPES.

THE collection of scientific apparatus on exhibition at the South Kensington Museum, in London, contains probably the first microscope ever made. It was constructed in 1590 by Zacharias Janssen, a spectacle maker of Middlebourg, Holland. It is a rough piece of work, made, as shown in Fig. 1, of three sliding tubes of zinc. The only scientific interest which it possesses, apart, of course, from the fact of its origin, is that it is compound—showing a reversed image. Janssen is better known to fame as the inventor of the telescope. It is related that Janssen's children, when playing one day with two powerful magnifying glasses, happened to place them one behind the other in such a position that the weathercock of a church, opposite the house, seemed nearer and larger than usual. Their father afterwards fixed the lenses to a board, and sent the apparatus as a curiosity to Prince Maurice of Nassau. Galileo, subsequently learning of the discovery, conceived the idea of applying it to the study of the heavens, and from his labors resulted the first useful telescope. That Janssen himself, however, did not fail to perceive some practical utility in his pair of lenses, the rough microscope which he produced furnishes abundant evidence. It was with this crude device that Malpighi afterwards discovered the capillaries, the structure of the skin in the human body, and was enabled to publish, in 1665, a description of all the nerves, vessels, and coverings of the tongue.

Great as were Malpighi's discoveries, it was reserved for Anthony van Leeuwenhoeck to make the microscope tell even a

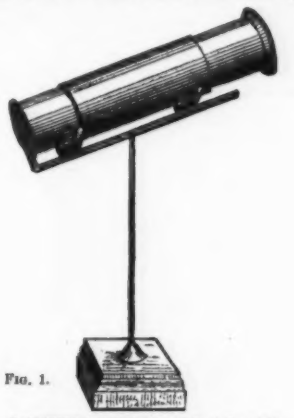


FIG. 1.

JANSSEN'S MICROSCOPE, A.D. 1590.

more wonderful story. Inventing a new instrument, he detected in water and in the insides of animals those extremely minute beings which he called animalcules. He showed that a piece of the soft roe of the codfish not bigger than an ordinary grain of sand might contain ten thousand of these living creatures. Leeuwenhoeck's great work was accomplished with the little apparatus which is represented in its natural size in Fig. 2. A minute lens is inserted at E in a silver plate. The object to be observed is held by a small pincers, F, which is rigidly attached to the piece P. The support is capable of motion in three directions—the screw A serving to raise and lower it, the screw B giving horizontal motion,

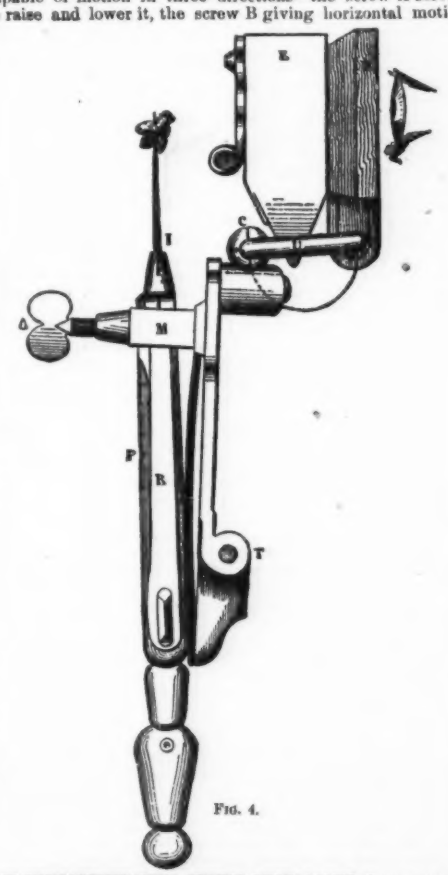



FIG. 4.

VAN MUSSCHENBROEK'S SIMPLE MICROSCOPE (OPEN FOR USE).

and lastly the whole apparatus may be turned on the screw R as a pivot, by which also the arm C is fastened after the adjustment is complete. The construction is crudity itself. Silver is used throughout, and the base plate is evidently taken from some piece of silverware, as the silversmith's marks and ornamentation are still faintly visible. Van Leeuwenhoeck was born in 1632, and died in 1723. The bicentennial of the year of his discovery of the animalculæ was recently celebrated in Holland.

Jan van Musschenbroek was a mechanic, and the fact is visible in the neater execution of his apparatus, Figs. 3 and 4 (natural size), and in his somewhat ambitious efforts to gain universal motion for his objects by novel contrivances. His is a simple microscope, and of our two engravings, Fig. 3 shows it closed, and Fig. 4 set up for use. The fly which constitutes the object is represented impaled on the needle I in Fig. 4, which is fastened to a long arm, P, which passes

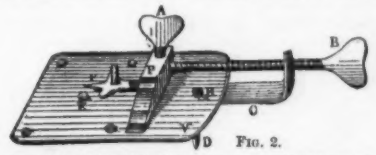



FIG. 2.

ANTHONY VAN LEEUWENHOECK'S MICROSCOPE, 1632-1723.

under a cross piece, M, and is articulated curiously at T. The handle is of wood. By means of the screws A and B the object holder is caused to move in two directions. A spring, N (Fig. 3), and another, K (Fig. 4), aid the screws, so that A lowers or raises the arm P, while B carries it to the right or left. C is a kind of hinge which connects the eyepiece to the rest of the aparatus, the pin of the hinge being a piece of copper wire, U.

In the piece D are inserted several lenses of different powers, any one of which, by turning the plate on its pivot, can be brought before the eye. The box E and the cover H form the eyepiece. The cover is of horn, the box of metal, and through both a hole is made, conical in form, the outer opening being about as large as the eye.

These three instruments are justly accounted among the

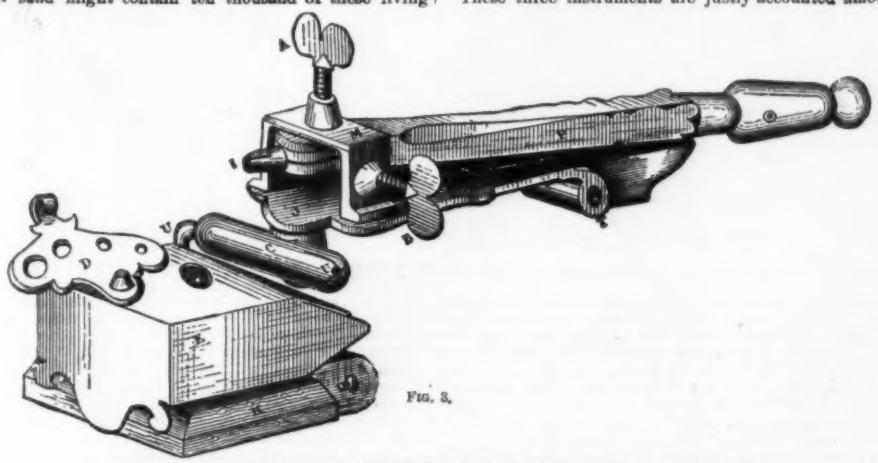


FIG. 3.

VAN MUSSCHENBROEK'S SIMPLE MICROSCOPE (CLOSED), 1687-1748.

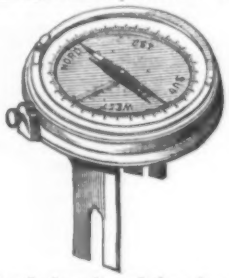
most interesting of the many priceless relics now gathered in London. They are in truth the earliest known microscopes, but they are by no means the first ever made. Janssen invented, it is true, the compound microscope as known to us, but the invention of the simple microscope lies many centuries back. Seneca mentions globes of glass filled with water being used to magnify natural objects very highly. Lenses have been excavated in Herculaneum, and from the ruins of ancient Nineveh have been taken bits of rock crystal too perfectly cut as magnifying glasses to warrant the belief that they served but for personal adornment.

## BERTHELOT'S NEW OZONE APPARATUS.

WE have already noted M. Berthelot's recent important discoveries in the thermic formation of ozone. In the annexed engraving is represented his novel apparatus for the production of ozone by means of the silent electric discharge. It consists in a glass tube *c*, to which are connected two smaller tubes *a* and *b*. Another tube, *d*, is placed in the large tube The apparatus is filled with a conducting liquid, water acidulated with sulphuric, and inserted in a test tube filled with the same. The electrodes communicate with the liquid in the interior tube, and with that in the test glass. The silent discharge takes place in the annular space between the tubes *c* and *d*, and acts on the oxygen which enters at *a* and escapes at *b*. The gas is thus transformed into ozone through the influence of the current. This is probably the simplest apparatus yet devised for the purpose.

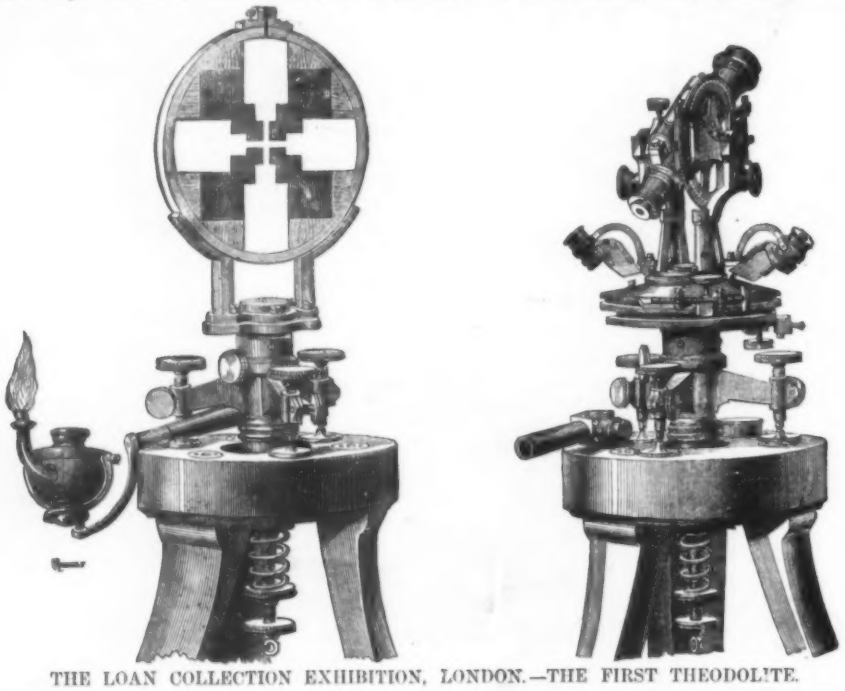
## THE FIRST MINING THEODOLITE.

AMONG the minor historical science exhibits at South Kensington, is a German pamphlet published in the year 1800, and containing a detailed description of a then new surveying instrument designed by Mr. H. C. W. Breithaupt, at that time instrument maker to the Court at Cassel. In this pamphlet the instrument is described as the first mining theodolite; it consisted of a horizontal circle divided into degrees, and supplied with a vernier, a graduated arc for vertical angles, and a telescope and level. There were also stands supporting signal disks and lamps. The brother of the inventor, Mr. F. W. Breithaupt, developed the original idea by several improvements, and some of these improved instruments were supplied to the Brazilian Mining Association in 1832, and to the Royal Prussian Mining School, at Saarbrücken, in 1836. The instrument as exhibited at South Kensington was still further improved by the son of the inventor from Cassel, and in its present form, as illustrated above, it consists of a horizontal silver circle 5½ in. in diameter, divided into half degrees, and fitted with two verniers and reading lenses. The vertical arc is of the same size and similarly divided. The telescope has



a spirit level placed above it, and there is a second tube and eyepiece for right-angled readings which can be attached to the telescope. The left-hand figure of the engraving shows the instrument fitted with a signal disk, and this latter or the theodolite can be attached to the same tripod. A compass, shown above, can easily be added to the projecting axle of the telescope; this compass is divided into half degrees.

Besides the instruments we illustrate, there are two smaller theodolites by the same maker, with the telescope arranged at the side, at South Kensington.—*Engineering.*



THE LOAN COLLECTION EXHIBITION, LONDON.—THE FIRST THEODOLITE.

## BRITISH ASSOCIATION.

### THE EFFECT OF ESMARCH'S APPARATUS ON THE CIRCULATION.

DR. GAMGEE read a paper on the changes of circulation which are observed when blood is expelled from the limbs by Esmarch's method. He stated that experiments carefully conducted on Esmarch's method with healthy students had produced the following results: When the blood was expelled from one leg the heart beat more rapidly, but only for a short time, and the same result followed the application of the bandage to the second leg. When the heart began to beat at its usual rate the tourniquets were loosened, and in an instant the limbs, previously blanched, became suffused with a blush, while sensibility therein became more and more blunted, and the heart bounded off at an exceedingly rapid rate, to return, however, to its normal beat almost immediately. In applying the bandage the blood in the veins was first expelled, then that in the arteries, and next there was an expulsion also of the lymph. He was of opinion that compressing the limb would send more blood into the veins than into the arteries, and, as the lymph would go to swell the venous pressure, the venous blood *plus* the lymph would be greater in amount than the blood sent into the arteries. But the valves in the veins would prevent the increase of pressure in all parts of the system. It had been suggested that the increase of heart-beat, when the bandage was applied, was intimately connected with the diminution of the normal difference between arterial and venous pressure—that, if the right side of the heart be subjected to greater pressure, that would cause an increase of the cardiac contractions. These certainly were facts making it likely that an increase of pressure on the right of the heart tended to quicken the heart-beats, and the quick beats on the removal of the bandage were, no doubt, the result of the removal of the arterial pressure.

### THE AGE OF THE EARTH.

The Secretary, on behalf of Mr. James Croll, of the Geological Survey of Scotland, read a paper on "The Tidal Retardation Argument for the Age of the World." He said: Many years ago, Sir William Thomson demonstrated from physical considerations that the views which then prevailed in regard to geological time and the age of our globe were perfectly erroneous. His two main arguments, as are well known, were—first, that based on the limit to the sun's possible age; and second, that based on the secular cooling of the earth. More recently he has advanced a third argument, based on tidal retardation. It is well known that, owing to tidal retardation, the rate of the earth's rotation is slowly diminishing, and it is therefore that if we go back for many millions of years we reach a period when the earth must have been rotating much faster than now. Sir William's argument is, that had the earth solidified several hundred million years ago the flattening at the poles and the bulging out at the equator would have been much greater than we find them to be. Therefore, because the earth is so little flattened it must have been rotating when it became solid at very nearly the same rate as at present. And as the rate of rotation is becoming slower and slower, it can not have been so many millions of years back since solidification took place. A few years ago I ventured to point out what appeared to be a very obvious objection to the argument, and as the validity of the objection, so far as I am aware, has never been questioned, I had been induced to believe that the argument referred to had been abandoned. But I find that Professor Tait, in his work on "Recent Advances in Physical Science," restates that argument as perfectly conclusive, and makes no reference to my objection. As the subject is one of very considerable importance, I may be permitted again to direct attention to the objection in question, which briefly is as follows: It has been proved by a method pointed out a few years ago, and which is now generally admitted to be reliable, that the rocky surface of our globe is being lowered on an average by sub-aërial denudation at the rate of about one foot in 6000 years. It falls as a consequence from the loss of centrifugal force resulting from the retardation of the earth's rotation occasioned by the friction of the tidal wave that the sea level must be slowly sinking at the equator and rising at the poles. This, of course, tends to protect the polar regions and expose equatorial regions to sub-aërial denudation. Now, it is perfectly obvious that unless the sea level at the equator has, in consequence of tidal retardation, been sinking during past ages at a greater rate than one foot in 6000 years, it is physically impossible that the form of our globe could have been very much different from what it is at present, whatever may have been its form when it consolidated, because sub-aërial denudation would have lowered the equator as rapidly as the sea sank. But in equatorial regions the rate of denudation is no doubt much greater than one foot in 6000 years, because the rainfall is greater there than in the temperate regions. It has been shown that the rate at which a country is being lowered by sub-aërial denudation is mainly determined, not so much by the character of its rocks as by the sedimentary carrying power of its river-systems. Consequently, other things being equal, the greater the rainfall the greater will be the rate of denudation. We know that the basin of the Ganges, for example, is being lowered by denudation at the rate of about one foot in 2300 years, and this is probably not very far from the average rate at which the equatorial regions are being denuded. It is, therefore, evident that sub-aërial denudation is lowering the equator as rapidly as the sea level is sinking from loss of rotation, and that, consequently, we can not infer from the present form of our globe what was its form when it solidified. In so far as the tidal retardation can show to the contrary, its form may have been as oblate as that of the planet Jupiter when solidification took place. There is another circumstance which must be taken into account. The lowering of the equator by the transference of materials from the equator to higher latitudes must tend to increase the rate of rotation, or, more properly, it must tend to lessen the rate of tidal retardation.

### NAVIGATIONAL DEEP-SEA SOUNDINGS.

Sir William Thomson read a paper on "Navigational Deep-Sea Soundings in a Ship moving at High Speed." He explained that now the work of taking a sounding was done by the aid of piano-forte wire, and the sounding line weighed only 30 lbs. instead of 300 lbs. in the case of a sounding of from 3000 to 5000 fathoms. The enormous advantage of the piano-forte wire for making soundings such as those he alluded to—soundings made in ships as nearly as possible at rest—led him to think it would probably also be found very successful for what the sailors called deep-sea soundings taken in from 30 to 200 or 300 fathoms of water, and which could not be made by the hand lead. It was very desirable that the sailors should be enabled to take deep-sea soundings without stopping the progress of the ship through the water. It was very difficult to stop a ship sufficiently to get a perfectly up and down cast, and besides that, the time required and the detention involved were very serious. Still, to get a good sounding in water of from 30 to 100 fathoms it was considered almost necessary to stop the ship. Various methods, however, had been adopted, which met with the approval of some sailors of great experience and good judgment, with the result that soundings could be obtained without diminishing the speed of a ship below 12 or 14 knots. The lead was carried forward to the bow of the ship, the sounding line to be used was held along the ship's side outside the rigging, each man held a few of the coils of rope in his hand, and the rope was thrown out as freely as possible. This method was sometimes practised successfully with a ship running as much as 13 or 14 knots. In soundings taken in this way the depth could not be exactly measured by the length of line paid out, and accordingly some other means had to be added. One method was to attach to the line a framework which measured the distance that the line went through the water, and if an accurate result was to be obtained it was necessary that the line should go direct down. But it was universally admitted by sailors that this method was not always perfectly sure, owing to the difficulty of getting the lead straight down through the water. Another method proposed, and which had been used with considerable success, was that of the compression of air. A glass tube, closed at one end and with a valve at the other end, was let down along with a sinker, the glass tube being full of air, and the distance the water was compressed into it would tell the depth to which the apparatus had sunk. This method was susceptible of giving exceedingly accurate results, and was well spoken of by sailors capable of giving judgment in such matters. The recovering of the sinker, however, was an exceedingly difficult process, because of the resistance given to the rope by the water. It took the whole watch to haul in the line—sometimes a dozen and sometimes twenty men. In some cable expeditions the piano-forte wire had been successfully tried, and on a recent trip to New York he was enabled to make experiments with it on board one of the Cunard Line steamers. Instead of the process he had described of carrying the sinker to the bow of the ship, he let the weight go direct from the stern, and in place of a weight of 56 lbs. of lead he used an iron bar of 22 lbs. He thought it would be well if sailors would come to talk about "the iron" instead of "the lead," because the former was cheaper and it answered quite as well. After describing the piano-forte wire system in detail, the professor proceeded to narrate a curious incident that occurred on his homeward voyage from America. While experimenting with the piano-forte wire the weight suddenly stopped, and in the course of two seconds more it began going again, precisely as it did when it reached the bottom. When the iron was brought out it was found to be marked with rock, and by his pressure gauge he found the depth it had been at to be 68 fathoms. Thus it was proved that at that depth, and in latitude 50 deg. 57 min., longitude 15 deg. 54 min. west, there exists a high rocky ridge. The experiment also proved that what was known as the Porcupine Bank extended southwards. The subject formed one that might well be investigated.

### LIGHT FROM A MAGNETIC POLE.

Rev. J. Kerr, LL.D., submitted an experiment proving rotation of the plane of polarization of light reflected from a magnetic pole. He stated that he had made certain experiments on the reflection of light from the bare surface of an electro-magnetic pole, and found that there was a sensible rotation of the plane of polarization, and that in this case of reflection from iron the magnetizing current carried the plane of polarization with it, so that the south magnetic pole of polished iron acting as a reflector turned the plane of polarization of the reflecting ray to the right.

Sir Wm. Thomson, in returning the thanks of the section to Dr. Kerr, said the phenomenon referred to by Dr. Kerr was a worthy consequent of Faraday's most remarkable discovery in a similar direction, and expressed his admiration of the sound knowledge and delicacy of manipulation shown by the reader of the paper.

### METALLIC REFLECTION.

Prof. G. Stokes read a paper on "A Phenomenon of Metallic Reflection," in which he gave an account of a phenomenon observed by him many years ago, and which was in some respects very remarkable. He explained that when Newton's rings were formed between a lens and a plate of metal, and were viewed by light polarized perpendicularly to the plane of incidence, it was known that, as the angle of incidence was increased, the rings which were at first dark-centred, disappeared in passing the polarizing angle of the glass, and then reappeared white-centred, in which state they remained until they could no longer be followed. At a high incidence the first dark ring was much the most conspicuous. To follow the rings beyond the limit of total internal reflection a prism must be employed. When the rings formed between glass and glass were viewed in this way, as the angle of incidence was increased the rings one by one opened out, uniting with bands of the same respective orders which were seen beneath the limit of total internal reflection; the limit or boundary between total and partial reflection passed down beneath the point of contact, and the central dark spot was left isolated in a bright field. Now, when the rings were formed between a prism with a slightly convex base and a plate of silver, and the angle of incidence was increased so as to pass the critical angle, if common light be used in lieu of a simple spot, we had a ring which became more conspicuous at a certain angle of incidence well beyond the critical angle, after which it rapidly contracted and passed into a spot. Prof. Stokes explained that to study the phenomenon in its purity, we must employ polarized light, or, what was more convenient, analyze the reflected light by means of a prism.

Sir Wm. Thomson explained that the very important discovery now given to the world had been made by the Professor a good many years since. Prof. Stokes said that, while he had discovered the great truth many years ago, he had not completed the necessary investigations till now.

### ANALYZING AIR IMPURITIES.

Mr. E. M. Dixon, Glasgow, described an apparatus for the analysis of impurities in the atmosphere. In this machine aspiration of the air is obtained by means of a pair of air-pumps, the piston-rods of which are connected with a beam to either end of which the working handle can be attached. The air-pumps are connected directly with a reservoir of the capacity of about eight cubic feet, and this reservoir again communicates with the atmosphere by six comparatively small tubes. Hence the working of the pumps gives rise on the one hand to a somewhat intermittent flow of air out of the reservoir through the pumps into the atmosphere, and on the other hand to a regular flow of air out of the atmosphere through the six tubes into the reservoir. The function of the reservoir is therefore simply to secure a steady flow of air in the direction of the pumps, notwithstanding their necessarily intermittent action. The air thus set in motion in several distinct streams toward the pumps is, before it reaches the reservoir,

first freed from the impurities in it by washing, and then measured as it passes through dry gas meters. The machine, Mr. Dixon went on to say, had been in regular use during last month (August), and had given results regarding the presumably very pure air prevailing in the district around the Mull of Kintyre that, so far as they have been worked out, appear to be quite reliable. The analysis of the samples of impurities was not yet quite finished, but Mr. Dixon had the opportunity of satisfying himself that the amounts, both of ozone and ammonia, were remarkably constant when the weather was dull and a fresh breeze was blowing either from the east or the west, while warm weather, accompanied with light winds, had the effect of more than doubling the amount of ammonia prevailing at other times, and when the amount of ammonia was exceptionally high that of ozone was exceptionally low. A satisfactory estimation of neither ozone nor ammonia could be usually had from much less than 100 cubic feet of air, and about 12 hours were spent daily in drawing that amount of air through the liquids. These facts would not appear surprising when it was known that on an average of 16 days the amount of nitrogen existing as ammonia in 100 cubic feet of air was only the fiftieth of a milligramme, while the average amount of ozone existing at the same time in the same quantity of air was less than one-twentieth of a milligramme.

PROTECTION OF BUILDINGS FROM LIGHTNING.

Professor Forbes read a paper by Professor Clerk-Maxwell on the "Protection of Buildings from Lightning." The paper stated that those who erected lightning-conductors had paid great attention to the upper and lower extremities of the conductor—having a sharp point above the building and the lower extremity carried into the earth as far as possible. The effect was to tap, or, as it were, to gather the charge by facilitating the discharge between the atmospheric accumulation and the earth. That would cause a greater number of discharges than would have otherwise occurred; but each of them would be smaller than those which would have occurred without a conductor. That arrangement was therefore more for the benefit of the surrounding country, and for the relief of the clouds laboring under an accumulation of electricity, than for the protection of the building on which the conductor was erected. What was really wanted was to prevent the possibility of an electric discharge taking place within a certain region. An electrical discharge could not occur between two bodies unless the difference of their potentials was sufficiently great compared with the distance between them. If, therefore, they could keep the potentials of all bodies within a certain region equal, or nearly equal, no discharge would take place between them. That might be secured by connecting all these bodies by means of good conductors, such as copper-wire ropes. It would, therefore, be sufficient to surround a powder-mill with a conducting material, to sheath its roof, walls, and ground floor with a thick sheet of copper, and then no electrical effect could occur within it on account of any thunderstorm outside. There would be no need of any earth connection. They might even place a layer of asphalte between the copper floor and the ground so as to insulate the building. If the mills were struck it would remain charged for some time, and a person standing on the ground outside or touching the wall might receive a shock, but no electrical effect would be perceived inside, even by the most delicate electrometer. A sheathing of copper was by no means necessary in order to prevent any electrical effect taking place. Supposing a building were struck by lightning, it was quite sufficient to inclose it with a network of a good conducting substance. For instance, if a copper wire were carried round the foundations of a house, up each of the corners and gables, and along the ridges, that would be a sufficient protection for an ordinary building against any thunderstorm in this climate; but it might be well, to prevent theft, to have it built in the wall, and then it would be necessary to have it connected with some metal, such as lead or zinc, on the roof. It need scarcely be added, says the writer, that it is not advisable during a thunderstorm to stand on the roof of a house so protected, or to standon the ground outside, or to lean against the walls.

On the motion of Mr. Symonds it was agreed that the paper be printed entire in the transactions of the society, in order that members might have time to study the subject.

A PNEUMATIC TRAMWAY CAR.

Mr. W. D. Scott-Moncrieff read a paper on "A Pneumatic Tramway Car." In pointing out the advantages of his invention, Mr. Scott-Moncrieff said that the use of compressed air for street locomotion was greatly superior to steam on the ground of general convenience. Heat and dust and disagreeable odors could not exist in an apparatus propelled by the air we breathed, and which, after doing its work, was returned to the atmosphere in its original purity. The compactness and simplicity, too, of the machinery allowed of its being contained in the car itself; and above all, the complication of furnaces and boilers and feed water and escaping gases were all swept away. In regard to its greater economy, he might say that the price of fuel suitable for firing a boiler that must pass through crowded thoroughfares was at least twice that which was necessary in a stationary engine; and, secondly, the stationary engine afforded opportunities for economizing fuel so greatly in excess of those that existed in a small locomotive that the consumption might safely be taken as one third. In describing his apparatus Mr. Scott-Moncrieff pointed out that his engines and reservoirs were, for the convenience of passengers, placed beneath the level of the floor, and that the length of the car, on account of the sharp curves, etc., was about 21 feet.

The President (Mr. Merrifield) complimented Mr. Moncrieff on the excellence of his invention, which, he said, had now passed beyond the experimental stage. He hoped that the greatest success would attend the new machine.

VORTEX RINGS—INTERESTING EXPERIMENTS.

Professor Osborne Reynolds read a paper on "Resistance Encountered by Vortex Rings, and the Relation between the Vortex Ring and the Stream-lines of a Disk." In the outset the author remarked that the comparatively small success which had attended nearly all attempts to refer the various movements of fluids to fundamental laws might, he thought, be attributed principally to our ignorance of many most important circumstances of motion attending the phenomena with which he wished to deal. It could be seen in which way the surface of a fluid moved, but of the internal motions observation gives no idea, we having no means by which to perceive them. His object on the present occasion was to describe certain results which had been obtained by coloring portions of the water within a tank so as to render them visible. These results were somewhat striking. The development of the theory of stream-lines, with which the name of the late Professor Rankine was so intimately connected, had been a great advance, from the theoretical side, in the study of fluid motion. This theory, however, only applies strictly to hypothetical fluids without viscosity; and its results, as applied to water, fall very far short of experimental verification. Thus, as was so beautifully illustrated before the section last year by Mr. Froude, a solid should move through a frictionless fluid in a rigid inclosure without resistance, the liquid moving out of its way, from front to rear, in filaments or streams, which closing together behind cause pressure which exactly balances the pressure in front. In fact, however, water opposes very great resistance to the motion of solids through it, as was shown by the fact that if a ball which would just float be allowed to fall from a great height into water would only descend a very short distance. The stream-line theory applied to the vortex ring. The idea of coloring the water to render its motion apparent was doubtless suggested by the effect of smoke and the beautiful phenomena of the smoke ring. That which was most striking in the smoke ring was the extreme beauty of its internal structure. When these rings are seen in water their rapid motion and the small disturbance which they cause, although only a few inches below the surface, are the most striking facts of the phenomenon. The speed of the rings diminished either in water or air, but there was a cause for this which could not properly be called resistance, and that was that they were continually adding to their bulk water taken up from that which surrounded them, and with which their former momentum had to be shared. The motion of the internal water, besides maintaining the shape of the boundary surface, is such that at each part of this surface the motion of the water in contact with it on the inside is identical with the motion of that in contact with the outside, so that not only is the bounding surface, at each instant, definite in form, but every point of the surface is in motion in exactly the same manner as the water in contact with it. The effect of viscosity on the ring is to diminish the velocity and extend the size of each element of the ring. The Professor next proceeded to refer to the disturbance of the stream-line of a solid passing through the water, to the relation between the vortex ring and the stream-lines of a disk, and the resistance of an inclined vane. Each of these theories, as well as the others, were, by the aid of a large tank filled with water, put to the test of experiment. The experimen s—more particularly those in which rings of colored liquid were propelled through the water, and the one in which air was sent through the water—were of a very interesting character, each experiment being loudly applauded by the audience.

## A NEW CHEMICAL TEST FOR ALCOHOL.

By EDMUND W. DAVY, A.M., M.D., Professor of Forensic Medicine, Royal College of Surgeons, Ireland, etc.*

WHILST making lately some experiments on molybdic acid, I observed that when a solution of that substance in strong sulphuric acid was brought in contact with alcohol, there is very quickly developed a deep azure blue coloration; and this fact, being (as far as I was able to ascertain) hitherto unrecorded, led me to investigate the reaction to determine the cause of this production of color.

As I found that the protosulphate of iron, and the protochloride of tin, two powerful deoxidizing salts, produced a similar effect on this solution, there was but little doubt that it was due to the deoxidizing action of alcohol on the molybdic acid. And I afterwards found that the blue substance which was formed in the case of alcohol possessed all the characters of the blue compound which is produced when molybdic acid or its salts are acted on by different reducing agents, whereby a substance consisting of five atoms of the metal molybdenum with fourteen of oxygen is obtained, which is usually regarded as a combination of the binoxide of molybdenum with molybdic acid, the following formula ($MoO_2$, $4MoO_3$) representing its composition.

With certain precautions, which I shall presently point out, I have found that this reaction of alcohol on the molybdic solution stated is extremely sensitive, so that by its indications very minute quantities of alcohol, even when diluted with large proportions of water, may be readily detected. Thus, for example, if one part by volume of commercial rectified spirits be mixed with 100 parts of distilled water, and one small drop of this mixture be taken, the minute quantity of spirit contained in it can be easily detected by the deep blue coloration which will be immediately developed on bringing it into contact with the molybdic solution, employed in the manner about to be described. But this is not the limit of the delicacy of this test, for I have been able by means of it to detect the spirit in one drop of a mixture of distilled water and anhydrous spirit, in which the latter substance constituted only the one-thousandth part of its volume; and as the drop was found to weigh $\frac{1}{10}$ths of a grain, the quantity of real or anhydrous alcohol contained in it would be less than the $\frac{1}{1000}$th part of a grain of that substance.

Though small quantities of spirit, even when considerably diluted with water, will produce with the molybdic solution the blue reaction without the assistance of any external heat, still, where very minute quantities, diluted with such large proportions of water as those just stated, are to be detected, it is necessary, for the success of the experiment, that the reaction should be assisted by a gentle heat, and also that too great a dilution of the test solution with the liquid under examination should be avoided, as the blue coloration will not be developed if water be in excess; and even after it has been produced, the addition of a certain proportion of that substance quickly causes its disappearance. Such being the case, the best way of employing the test, according to my experience, is to place three or four drops of the molybdic solution in a small white porcelain capsule, and having heated them slightly, allow one or two drops of the liquid to be examined to glide or fall gently on the acid solution, when there will be developed, either immediately or after a few moments, the blue coloration. And, where the alcohol is very largely diluted with water, it is better to continue the gentle heating of the test solution for some time, to concentrate it or expel as much water from it as possible, before adding the liquid to be tested, for, in this way, I have succeeded in detecting the spirit in mixtures so dilute as to give no blue reaction when added immediately to the test solution on its being simply warmed. As regards the application of heat, I must observe that the temperature of the acid solution must not be raised too high, for if it be heated till the acid evolves its dense vapors, or begins to boil, the solution will of itself alone, from its partial decomposition, develop a more or less blue coloration, which will become more perceptible on its cooling. But such an occurrence can be easily avoided by employing a water-bath as the heating agent; for I have found that a temperature of 212° F. is incapable of so acting on the test solution—at least an exposure of several hours' duration to that heat failed to produce the slightest blue coloration, and a much lower temperature than that suffices for the application of the test.

I should here state that the molybdic or test solution which I have generally employed was made by dissolving at a gentle heat one part by weight of molybdic acid in ten parts of strong and pure sulphuric acid, but the exact strength of this solution as regards the amount of molybdic acid it contains seems to be immaterial.

I may observe that the coloration produced in the reaction stated disappears after a variable interval of exposure to the air—a circumstance which is due, as I have ascertained, to the absorption of moisture from the atmosphere, and not to the re-oxidation of the molybdenum compound, as might have been supposed; for amongst other facts in proof of this, I may state that after it has thus disappeared, it may be readily restored either by expelling the water so absorbed by a gentle heat, or, more slowly, by placing the mixture under a desiccator, and thus removing it by spontaneous evaporation at the ordinary temperature. Such being the case, it is evident that, where the test solution has been too much diluted for the immediate development of the coloration described, expelling the excess of water by heating the mixture on a water-bath, it may be made to exhibit itself.

But the necessity for such evaporation should, if possible, be avoided, which, in most cases, will be so by using only a drop or two of the liquid under examination, and by employing the strongest sulphuric acid in making the test solution; for it is very probable that much of the spirit contained in the liquid would be lost during its evaporation in the water-bath; besides, there would be some risk that the indications of the test might be more or less interfered with from particles of dust or organic matter getting into the mixture during that process.

The reaction which has been described, I should state, is not peculiar to ordinary or ethylic alcohol, but is more or less readily developed by others—at least I found it to be so in the case of methylic, propylic, butylic, and amylic alcohols, those being the only ones I had for my experiments. But it is more than probable that some at least of the other alcohols may act in a similar manner; however, the reaction is much more rapid and striking in the case of ethylic than in that of any of the other alcohols mentioned. I found also that certain salts of the radicles of those alcohols produced a somewhat similar reaction, as well as ethylic ether and aldehyd, and also several organic matters which are readily susceptible of oxidation.

The circumstance that the reaction described is not peculiar to ethylic alcohol will, no doubt, lessen its value as a positive test for that substance; but a similar objection appertains to all the other known tests for that compound, as their indications are not peculiar to that alcohol alone, if we except, perhaps, Berthelot's test, which is founded on the development of benzoic ether by the action of benzoic chloride, along with caustic potash on ethylic alcohol. But, owing to the trouble attendant on the preparation of benzoic chloride, and some other practical inconveniences connected with the application of that test, it is not likely that it will ever come to be one of very general employment.

The test, however, which I have brought before the Academy has this advantage over those already known, that it far exceeds (according to my experiments) any one of them in point of delicacy. And though the circumstance that the blue reaction produced in the case of this test is not peculiar to ethylic spirit lessens, as before observed, its value for the detection of that substance, this is just what renders the test of more general applicability; for by its aid certain impurities or adulterations may be at once detected in different substances or compounds, which in a state of purity should not contain any matter capable of acting on the molybdic solution employed in this test. I may refer to two important substances as examples—namely, chloroform and chloral hydrate, which are now so extensively employed in medicine and surgery for a number of useful purposes; and being agents of great power, it is of much importance that they should be free from the accidental impurities of imperfect preparation, as well as from the frauds of intentional adulteration, which may either impair their therapeutic value, or even increase the danger of their administration. For there can be but little doubt that in some instances the serious and even fatal effects resulting from their use may, in part at least, have been attributable to the impurities or adulterations of the chloroform, or of the chloral hydrate employed. Now, as I find that neither chloroform nor chloral hydrate, in their pure condition, have any apparent action on the molybdic test, but that many of their usual impurities develop the blue reaction, it affords us a ready means of testing their purity. Thus, as regards chloroform, one of its common impurities is ethylic alcohol, which it may contain either from imperfect preparation, or from fraudulent addition, the very high price of chloroform offering a great temptation to the unscrupulous vendor to increase its bulk or weight by the addition of alcohol, which so readily mixes with it. I have found that the molybdic test at once enables us to detect such an adulteration, even where it occurs in very small proportions in chloroform. Thus, in one experiment, I mixed one part of rectified spirit with 100 parts by volume of pure chloroform, and one drop of this mixture being brought in contact with three or four drops of the molybdic solution, previously warmed in a water-bath, gave an immediate deep blue coloration from the spirit contained in it; and, in a second experiment, with a mixture of one part of spirit to 1000 parts of chloroform, a single drop of the mixture, being similarly treated, developed a faint blue reaction. Indeed, so searching is this test as regards the purity of chloroform, that I was unable to obtain any sample of that substance in commerce sufficiently pure not to give a blue reaction with the molybdic test, owing to the minute quantities of volatile oils, and other impurities, they contain; and for my experiments I was obliged to repurify the commercially pure chloroform to obtain a sample which would give no colored reaction with my test.

In the case of chloral hydrate, it is stated that one of its usual impurities is the chloral alcoholate (a compound in which alcohol, instead of water, is combined with anhydrous chloral), and that this substance has somewhat different effects on the system from those produced by the hydrate. This compound, owing to the alcohol it contains, gives the blue reaction with the molybdic test, and I have found that where the chloral hydrate contained even so small a proportion of the alcoholate as 1 part in 1000 parts, a little of such a sample being taken indicated its presence when examined by the molybdic test; and it is probable that some of the other impurities which are met with in this important substance may be similarly detected.

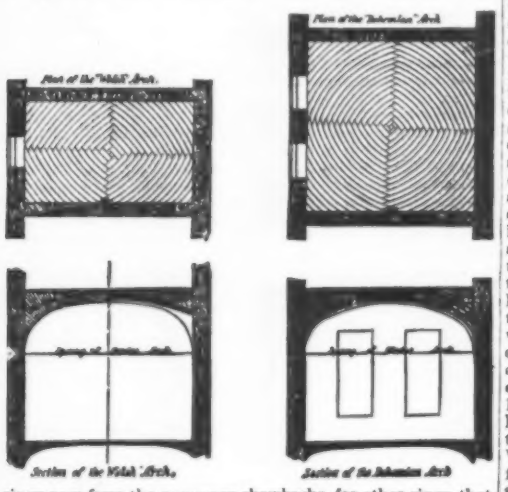
Those two examples are sufficient to indicate the use to which this test may be applied in the determination of the purity of different substances used in medicine, as well as in scientific research.

Finally, I would remark that, as the reaction of molybdic acid on ethylic alcohol is so sensitive and prompt in its action, I entertain the hope that there may yet be founded on it, not merely this qualitative test, but likewise a means for the quantitative determination of that important alcohol.

* A paper read before the Royal Irish Academy.

## VAULTED FLOORS.

THE system of vaulted floors, called *Platzel-Gewölbe*, in use in Vienna, and peculiar to Austria, is worth describing. The space to be floored is divided into compartments or cells not larger than 20 feet square by arched girders of brick-work. Reveals are left on the sides of the girders to give a proper footing at the spring of the vaultings; and grooves are cut in the face of the walls where they abut, for the same purposes. The vaults are built by the eye alone, without any centring whatever, and are begun simultaneously in all the four angles of the apartment. Flat arches are built across these angles, like squinches, in successive rings, side by side, which of course widen as they recede from the angles, and rise slightly toward the middle of the compartment, forming a kind of pendentives, till they meet in the centre of the sides. Half the space is thus vaulted with a series of arches, each self-supported, abutting against the walls and girders, and enclosing an open square whose angles are tangent to the sides of the original square at their centres. The planes of these rings are not quite vertical, but incline outwards at the crown toward the angles of the compartment, so as to give the requisite rise of the vault towards the middle, and keep the joints normal to the soffit. The inclined sides of these




rings now form the necessary skewbacks for other rings that are built within them, which, no longer reaching to the walls and girders, must abut upon each other, and, continually diminishing, close at last in the centre of the cell. This kind of vault is called the Bohemian vault, and is only used where the cells are square or nearly so. Its section is a flat semi-ellipse, or rather semi-oval, the arches being almost tangent to the walls at their springing. When the compartments are sufficiently narrow—not over 10 or 12 feet—another kind of vault is used, called the Welsh vault, which may be extended over an oblong of 20 feet long or more. The Welsh vault differs from the Bohemian in being segmental in section along both axes, so that when square in plan it is a spherical surface. It is flatter than the other, having a rise of only half an inch to the foot, and can not be so strong; but it is probably easier to construct, and is in common use for halls and corridors that are narrow enough for it. These vaultings are only a single course (say 6 inches) in thickness; but the Bohemian vault is usually backed on the flanks for a considerable height with one or two additional courses, which is desirable on account of the well-known tendency of an elliptical arch to rise at the haunches under pressure at the crown. —*Amer. Architect and Building News.*

## THE CONSTRUCTION AND USE OF TAPS.

By JOSHUA ROSE.

OF all the tools used in a machine shop, none is more important than the tap, nor can we deviate in any direction from its one proper shape without falling into serious errors entailing a great loss of time, involving much more severe labor, and impairing the quality of the work performed. That we frequently see taps of different design is true, and the reason is to be found in the fact that there are involved in their manufacture several somewhat intricate points which too often escape the observation of the ordinary mechanic, and sometimes, indeed, that of the tap manufacturer. The most important of these considerations are the method of giving the taper tap its taper, the amount of clearance in the thread, and the number and shape of the grooves.

For executing the finest and most exact of work, taps of an inch and less in diameter should be made without any clearance in the thread. The thread should be made parallel, and the taper to the taper and plug tap should be given as follows: For the taper tap the thread should be turned off so that the entering end is of the diameter of the bottom of the thread, the taper running straight, and leaving about six full threads at the other end of the tap. By this means, there being no clearance in the thread, the tap will work very steadily, and will tap a hole, in which the tap itself will be a neat fit, while all the holes tapped will be of exactly one size. By giving the tap a long taper it will work easier, and is not so apt to tap out of straight; for a tap having no clearance on the thread is very difficult to right if it once gets out of straight after it has entered the hole to more than one quarter of its length. The plug tap should be made in like manner, and tapered off for about four threads from the end. The tops of the threads may be eased off by drawfiling from the back gradually toward the cutting edges; but very little clearance need, however, be given. Another and very good plan of easing the friction of the tap is to file a flat place along the tops of the teeth, extending along each tooth nearly to the edges.

On taps for ordinary use, however, it is better to give the thread a very small amount of clearance—just enough to relieve the sides and top of the tap from contact—the object being to reduce the friction of the thread in the hole, and not to sharpen the angles forming the cutting edges. This clearance, no matter what its amount may be, is just so much liberty given to the tap, enabling it to operate unsteadily, and, therefore, to tap a hole of larger diameter than itself. It is apparent, however, that an amount of clearance so small may be employed that it will ease the sides of the thread from positive contact, without entailing any material play of the tap in the hole, bearing in mind that so far we have referred to taps having their diameters at the top or bottom of the thread parallel from end to end. It is not uncommon, however, to make taper taps taper in the diameter of the thread, a course which does not possess a single point of advantage, but which, on the contrary, entails several positive and serious disadvantages—as, for example, where the teeth do not lie in the plane of the grooves which they cut in the work; and, furthermore, the groove or grooves, cut by each tooth individually, or the whole of the teeth collectively, is not so large in diameter as are the teeth themselves.

Suppose, for instance, we take the case of the parallel and taper-threaded taps shown in our engraving, in which Fig. 1 represents a taper parallel in the diameter of the thread, but tapered off, by the removal of part of the thread at one end, in the manner usually applied in American manufacture. The distinctive feature is that the tapering is not made to extend so far up the length of the tap as it is in English manufacture. Suppose the sides of the thread to have sufficient clearance just to clear the sides of the thread from positive contact with the grooves cut in the work to form the thread. Now let Fig. 2 represent a tap of the same size and pitch, but having an amount of taper in the diameter of the thread sufficient in the length of the tap to equal twice the depth of the thread, so that it will enter the same size of hole as will the tap shown in Fig. 1, without having any of the thread turned off, and we have the following state of existing facts: The full diameter of the taps being an inch, the circumference of the top of the thread at the large end of each will be equal to the length of the line A in Fig. 3. The line B representing the pitch of the thread, and C C representing the centre line of the length of a tap or bolt, we have the line E as representing the angle of the top of the thread to the centre line of the tap. And in the case of the tap shown in Fig. 1, this angle is constant at all parts of the tap. This is not, however, the case with the tap shown in Fig. 2, in which the angle of the thread to the centre line of the bolt varies at every part of its length. The angle at the largest end will, it is true, be that of the line B in Fig. 3; but turning our attention to the small end we shall find as follows: Suppose that in Fig. 4 the line A represents the circumference of the top of the thread, and B the pitch of the thread; we have then the line D as representing the angle of the top of the thread to the centre line C C of the tap. If we now turn to the angles of the bottom of the threads on the two taps, we shall find that the circumference of the tap shown in Fig. 1 being at the bottom of the thread equal to the length of the line A in Fig. 3 from the point 1 to the point 2, and the line G representing the pitch, we have the line D as representing the angle of the bottom of the thread, at every part of the tap, to the centre line C C. Whereas in the case of the tap shown in Fig. 2, the circumference of the bottom of the thread at the large end being the full length of the line A in Fig. 4, the circumference at the small end will be equal to the length of the line A (Fig. 4) from the point 1 to the point 2, and the angle to the centre line is therefore represented by the line F. As a result, this angle varies at every part of the length of the tap.

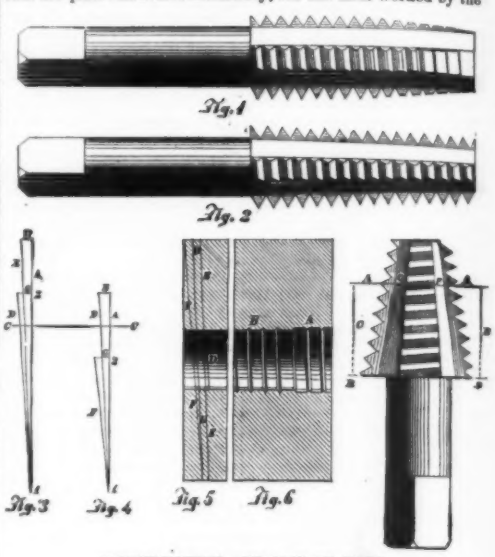
The consequence of these angular variations we shall find operate, from every point of consideration, to the detriment of the tap shown in Fig. 2, as will be seen on reference to Fig. 5, which represents the section of a piece of iron with a tapping hole in it, and in which D D represents the angle of the groove which the small end of tap No. 2 would cut on entering the hole. Since the angle of the bottom of this groove requires to be that denoted by the line E, it follows that the teeth or each tooth cuts a groove standing at a different angle to itself; or in other words, each tooth stands crosswise in the groove which it cuts, thus entailing a large amount of friction on the sides of the thread. In addition to this, we must remember that since the angle of the bottom of the thread is denoted by the line F in Fig. 4, then as the teeth of the tap enter the hole to a certain depth, they approach to an angle corresponding to the angle of the line F in Fig. 4, which is denoted by the line F in Fig. 5; and as a result, the variation of the angle which the teeth actually cut to the groove when finished varies, at the largest diameter of the groove, between that of the line E and the line F in Fig. 5. This, however, is not the case with the form of tap shown in Fig. 1, because the angle of the bottom and top of the thread on the tap is the same in every part of its length.

There is, however, another and important consideration in that the tap shown in Fig. 1 finishes its work as it performs it, while that shown in Fig. 2 keeps going over the same ground, nothing being finished until the tap has passed entirely through the hole—that is to say, providing the hole requires to be parallel. The action of tap No. 2 is to cut a V groove deeper and deeper as the tap enters, while the action of tap No. 1 is to leave a V projection. Now while the V groove is continually altered in its angle to the centre line of the bolt beginning at the angle D in Fig. 5, and ending at the angle E in the same figure, the angle of the V projection remains constant from the first to the last of the tapping operation.

In Fig. 6, which represents a piece of iron with a hole in it, in which tap No. 1 has been entered at A, and tap No. 2 at B, it will be observed that the action is in the first case to cut out metal, leaving the thread intact and finished as far as the duty has proceeded; while in the other it is to cut out a groove of the greatest angle and to continue to operate upon it until it becomes of the least angle, so that the effect is as follows: Suppose a hole to be tapped all through to one half a full thread, and we require to put in another tap to make it a full thread; then tap No. 1 would be relieved of any friction from that part of the thread already cut, whereas tap No. 2 would not. Many taper taps are made parallel in their thread all along, except for about three quarters of an inch from the entering end, in which case the evils here shown, though reduced, exist nevertheless in precise proportion to the amount of the taper.

In the case of pipe or gas taps, which usually have a maximum of taper upon them, we have yet another consideration of great moment, in that the teeth of the tap do not cut a groove of a diameter sufficiently large to allow themselves to pass through without being forced through. It will be readily perceived on reference to Fig. 7, which represents a gas tap, that the diameter of the thread increasing as it approaches the back B B of the tap, and A A being a line running true with the top of a tooth, and approaching nearer to B B at one end than it does at the other end (as denoted by the lines C and D), therefore the diameter of the cutting edge P of the tooth is not so large as the diameter of the back of the tooth at O, and the tooth does not therefore cut a groove sufficiently large to allow itself to pass freely through. In addition to this, it must be borne in mind that all the defects shown as applicable to tap No. 2 are largely magnified (by reason of the increased taper) in the gas tap, and it therefore follows that it may be given a considerable amount of clearance in the thread, which clearance is necessary to relieve the sides of the thread from undue friction without giving them any freedom or play.

It will be noticed that the corners of the square ends of all the taps here illustrated are chamfered off; and this is highly necessary, and much too frequently neglected. If a wrench fits accurately to the square of a tap, as it should do, then in all cases in which the wrench requires to be taken on and off the tap—and such cases are very frequent—a loss of time is entailed in adjusting the wrench to the tap head, so that it will enter especially in the case of single wrenches. Let the maker of a tap or reamer, with these corners not chamfered off, be put to the task of tapping or reaming a hole at the bottom of a locomotive cylinder saddle, and in many other such situations, and he will find that the presence of those corners involves an increase of *at least* cent per cent in the cost of the work. I have known taps and reamers to have the corners left on so as to prevent their use by boiler-makers, and for all holes save those in which the wrench did not, during the operation, require to be lifted from the tap, and the plan answered admirably, for the men worked by the

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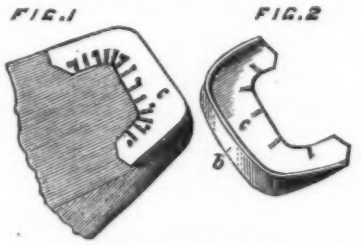
piece, and could not afford to throw away any time. The wrenches were solid ones, and they could not use a wrench fitting loosely to the tap. In the case of adjustable wrenches, the effect of leaving these corners on is to induce a very easy adjustment of the wrench, and a corresponding destruction to the square of the tap, by rounding its corners. Taps made for use in a tool room, and for use by slow and cautious workmen, may have the corners left on, and it will be a demonstration of the fact that a fair quantity of very accurate work is done then; but at the same time it will be noticeable that a large quantity of ordinarily good work is not attempted, for just so much difference will even this small point make.

## RAW-HIDE SHOE TIPS.

By J. A. STOCKWELL, Boston, Mass.

THE raw hide from which tips or protectors are made is unhaired, unfleshed, and rinsed in the usual manner, and after being removed from the rinsing vat is prepared for coloring by being run through a lukewarm logwood liquor. The hides opened out flat are laid one above the other in a vat containing enough of this lukewarm liquor to cover and saturate them, as it has been ascertained that the logwood liquor acts the most rapidly, and produces the best results, when about lukewarm. Then the hides so treated are soaked in a dyeing liquor composed of logwood liquor, nut galls, blue vitriol, vinegar, and an iron set.

The hides, after being properly dyed—the color being a deep black, and permeated through the entire substance of the hide—are stretched, dried, and polished. Then to manufacture the tips or protectors the hide is moistened and cut by dies into pieces of the form desired, the pieces are moulded or shaped in moulds and are then dried, when they may be polished, if desired; the hide treated and dyed as herein described being capable of taking a deep black, and the tip or protector when formed will be hard and susceptible of taking a polish much like hard rubber.




RAW-HIDE SHOE TIPS.

In the drawings, Fig. 1 represents a tip or protector attached to a form on which it is dried; and Fig. 2 is the tip moulded and ready to be made up into a boot. The tip is composed of a protecting edge, *b*, and a flange, *c*, the edge *b* extending about the toe, fitting the upper closely, and the flange *c* is adapted to extend between the toe of the upper and the sole, and receive pegs, nails, screws, or stitches by which the sole and upper are united, such fastenings extending through the flange and holding the tip in place. The tip shown in Fig. 2 is adapted for a toe-protector only, but it is obvious that it may be made with a protecting edge extending along the sides of the upper at its juncture with the sole.

In dyeing the hide the patentees make use of two solutions besides the logwood liquor. Solution No. 1 is made by boiling together, for five or ten minutes, four ounces each of pulverized nut galls and blue vitriol in a gallon of hot logwood liquor, and afterwards adding four quarts of vinegar saturated with iron, in the well-known way, or the chemical equivalents of the vinegar and iron may be used. Solution No. 2 is an iron "set" made by dissolving iron chips in aqua

fortis or other acids, the iron being added until a saturated solution is obtained.

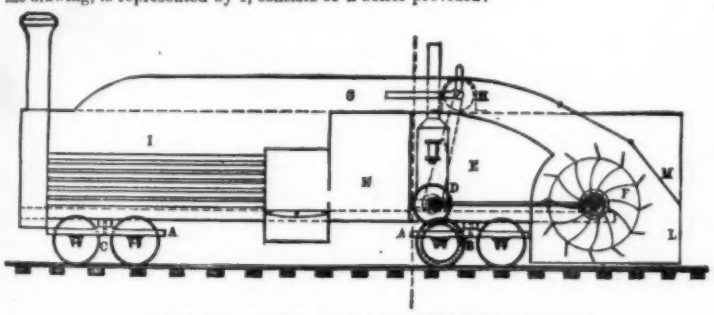
For the purpose of thoroughly blacking about half a dozen hides, or two or three dozen medium-sized skins, place the hides, which have been previously soaked in logwood liquor, in about twenty-four gallons of logwood liquor such as first described, and to which has been added about two quarts of the solution No. 1, and about one pint of No. 2 solution, the latter solution having a tendency to set the color or cause it to penetrate the hides. The hides should be allowed to remain in this dye liquor from one to three days, according to their thickness, they being frequently turned to secure a thorough penetration of the dyeing liquor into the hides. It may be remarked that the exact quantities above given are arbitrary, as the ingredients vary in strength, and some hides will take color more easily than others. The quantities mentioned will generally be sufficient to blacken two dozen calf skins or half a dozen kips or light cowhides, but the heavier hides require to remain longer in the dye liquor. The dyeing liquor only requires to be replenished as its strength is exhausted by the addition of fresh material to keep it in substantially the proportions just described. Maroon and purple colors may be made by working in the logwood liquor, and finishing by using aquafortis and tin with solution of logwood instead of the dyeing liquor above described.

Raw hide after being subjected to this treatment, in which it is only partially tanned, is rendered a deep and permanent color throughout its substance, is better capable of resisting moisture, and is susceptible to a high polish, giving it a neat and finished appearance similar to that of hard black rubber. It can be prepared at exceedingly low cost, does not become rusty or discolored by use, but retains its original neat appearance until completely worn out, and is thus of great value in the manufacture of tips or shields for the toes of boots and shoes, and of similar or other articles liable to rough usage.

## REMOVING SNOW FROM RAILWAY TRACKS.

By JOHN H. PIELERT, Baltimore, Md.

THE wheels B are connected by gearing to an engine, D, which propels the machine and operates the excavator F, which excavator consists in a wheel having buckets or paddles fitted to radial arms extending from a shaft or secured to rims at or near to the periphery of the wheel. The excavator is of such character as, when revolved, will conduct the snow driven therefrom by centrifugal force to a snow-funnel, G, from which it is delivered to the melting-chamber I. In addition to centrifugal force, which causes the snow to traverse the snow-funnel G, towards the melting-chamber, I employ fans H, driven from the engine, which force air into the funnel from the outside thereof in a direction corresponding with that of the moving snow. The melting-chamber, which, in the drawing, is represented by I, consists of a boiler provided



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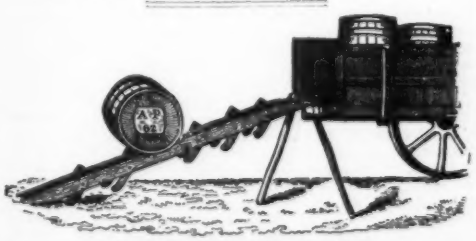
with heating-tubes and furnace, and is either open at the top or supplied with apertures sufficiently large to allow of the escape of steam generated from the melting snow. The melting-chamber and snow-funnel are constructed in such manner as to admit of the extensive distribution of the snow over the tubes and furnace, in order that the entire surface of the water, which extends above the tubes and furnace, can be utilized as a heater. Suitable overflow devices are used to prevent the superabundant accumulation of water in the heating-chamber. The fire-room, from which coal is fed to the furnace of the heating-chamber, is represented by K.

As it is necessary, in cleaning railroad tracks of snow, that the cut through the same should be of greater width than the rolling-stock, portions of the sides of the snow-funnel, which is enlarged at the end, forming the casing of the excavator, are hinged and adapted to be distended considerably beyond the sides of the engine-room and frame of the machine, but which are drawn in when the machine is not in use, or being transferred from one place to another on the track. The feeding-aperture L, at the forward end of the machine, is adjustable in height, by means of an apron, M, to suit the depth of snow and prevent the admission of air to the funnel to destroy the partial vacuum formed by the blast from the fans H.

It will be understood that the duty of the engine is not to force the snow from the track, as is done by means of the ordinary snow plough, but to merely keep the feeding aperture well up to the snow bank, and to overcome the reactionary tendency of the excavator, or its recoil.

Modifications of this apparatus may be made to adapt it for use on street railways, horses furnishing the motive power to operate the excavator, and by the attachment of brooms to sweep the track of snow left by the excavator, it will be found an efficient device.



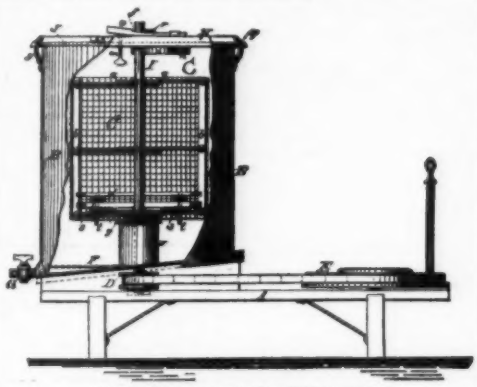
GERMAN BARREL LIFTER.

THIS device, used in Germany, consists in having the sides of the ladder provided with a series of pivoted stops, which swing in one direction but lock in the other, so that as the barrel is rolled up the stops will prevent it from rolling backward or down again.

## CENTRIFUGAL HONEY EXTRACTOR.

By JACOB EMMONS, St. George, Kansas.

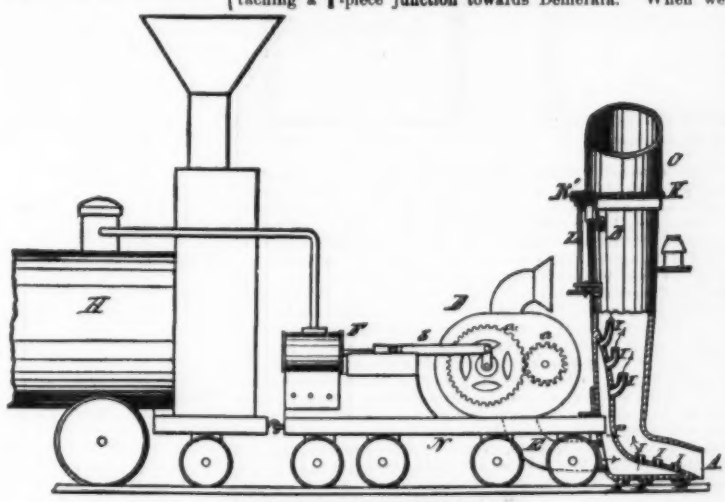
THE face of the comb containing the honey is placed against a wire gauge in a rotating frame C, and the honey is thrown out by centrifugal force, the comb being afterward placed in the hive to be refilled. Heretofore, however, it has been necessary to remove the caps from the cells of the honey-comb before placing it in the reel, in order to allow the honey to escape, this operation being usually performed by means of a long knife. To obviate the necessity of this operation is one of the first objects of this invention.



CENTRIFUGAL HONEY EXTRACTOR.

This opening of the honey cells is accomplished by giving an up and down motion to the comb while it is rotating in the reel, which motion causes the face of the comb to rub against the wire cloth, and by friction wear off the heads of the cells.

Rotary motion is given to the comb reel by the pulley E. The honey is drawn off from the vessel B through the faucet G



NOVEL SNOW-PLOUGH.

## NOVEL SNOW-PLOUGH.

By JOHN MABBS, Houghton, Mich.

H, ordinary locomotive engine; N, pilot attached to the front part of the locomotive. F, steam engine, which receives steam from the steam-dome of the locomotive through pipe G. D, case of an air-forcing engine, the wheels of which engine receive rotation from the pitman *b* through the medium of the spur-wheels *a a*, and forcibly eject air through pipe E into the snow scoop or shoe A. This scoop or shoe is flattened laterally, and is somewhat wider than the width of the track. It is formed on the lower end of a discharge-pipe, which is composed of two sections, B C, and which has a diaphragm, P, dividing the lower portion of the scoop and discharge-pipe. I, tubes, which are directed upward; M, tubes which are directed downward and outward from the shoe A. Tubes I spring from the diaphragm P, and through them air from the engine D is forcibly ejected. The upper section of the discharge-pipe is arranged at an obtuse angle therewith, and is adjustable about the vertical axis thereof by means of spur-wheels K K′, and a vertical shaft, L, on which is a hand-wheel accessible to the engineer. By these means the inclined section C of the discharge-pipe can be adjusted in any desired direction.

The snow which is picked up by the scoop A, will, by the strong blasts of air from the engine D, be forcibly discharged from the mouth of the section C far enough from the track to prevent drifts, the direction of the discharge being controlled by adjusting said section. The air ejected from tubes M will clear the track from any snow which will not be taken up by the scoop.

## TORPEDOES.

MR. WHITEHEAD, the inventor of the celebrated fish torpedo, has been in England for some days past with the object of inducing the Government to purchase some improved torpedoes, from which he anticipates great results. Each torpedo, we understand, costs the enormous sum of £400, but the purchase of fifty carries with it the subsequent right of manufacturing them. Austria, Sweden, and other countries have availed themselves of the terms offered, and for £20,000 have obtained possession of a projectile which is said to be not only far superior to any thing of the kind yet invented, but which would cripple a fleet before it had time to come within effective range. Fortified, however, by the results which have been obtained from a new submarine engine or rocket recently tried at Woolwich, the English Government are understood to have declined the terms which Mr. Whitehead placed before them. By enlarging the size of the torpedo, increasing the power of the air cylinders, and adding to the length of the propellers, the authorities of Woolwich have produced an engine of war which is capable of attaining a speed through the water of close upon twenty knots. This is the identical speed which the improved Whitehead torpedo is said to possess, but, in addition to its extraordinary speed, the latter has the power of running in a straight line. It has been impossible to prevent the present fish torpedoes diverging to the right or left, although in some instances a double screw working on the same shaft has been tried; and, besides this defect, their flight through the water is frequently accompanied by a vertical undulatory movement which enables their course to be followed. The new Whitehead torpedo, on the other hand, is guaranteed not to diverge more than a yard from a straight line within a distance of 2000 yards. The ordinary whiskers around the nozzle have been dispensed with in the improved torpedo, and in consequence the inventor asserts that it can make its way through the torpedo nettings without exploding, except by actual contact with the ship itself. Its length is 18 feet, or about 4 feet longer than those in common use.

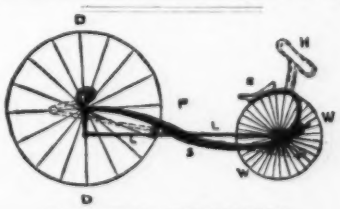
## TELEGRAPH CABLES CUT BY SAW-FISH.

GUTTA-PERCHA or india-rubber core, without any covering, is not so liable to damage from borers as core partly protected by imperfect sheathing. Bare india-rubber core is liable to damage from barnacles to a greater extent than gutta-percha, in consequence of its yielding nature; but on the other hand, the teredo will attack bare gutta-percha and usually leave bare india-rubber untouched.

Gutta-percha cable, the sheathing of which is much corroded or imperfect, so that the guards do not rest closely together, is utterly unfit for localities infested by the teredo.

But besides these there appears to be another enemy of a more vigorous nature, and which, unlike the borers, does not go slowly and steadily undermining his victim's health, but makes a manly, straightforward attack on him, injuring him at one blow. This is the saw-fish. Cables on the coast of Brazil, and also between Penang and Singapore, have been thus attacked. Thus Mr. Warren, in speaking at the Society of Telegraph Engineers, and alluding to the faults in the cable of the Western Brazilian Company, near Para, says:

There is one source of mischief to cables from marine life which I believe is a novelty—at least I am not aware of any similar instance being recorded. During the laying of the cable between Para and Cayenne, the cable was buoyed about thirty-five miles from Cayenne for the purpose of attaching a T-piece junction towards Demerara. When we proceeded the next day, after completing the section from Para to Cayenne, to form a junction to connect it with the Demerara cable, and picked up the buoyed end, we found the cable had gone down in insulation from a fault which, by tests, we localized to be about 126 miles from Para. We had to lift it for repairing, and within a length of thirty miles, we found no less than six faults, each of which contained fragments of a bony nature, which we supposed were caused by the bite of some marine animal, as the teeth were left in the cable. As these faults appeared after the cable was laid, we could not explain how a fish could attack a cable in this way. We removed these faults, and the cable was then as good as ever. We went out there again at the beginning of the present year (1875), when we found the cable faulty again in the same place, or about 129 miles from Para, and here we found two faults similar to the former ones, and produced by the same means and in the same way. We subsequently had occasion to go to the same spot again in July, when we picked up three more faults within 150 miles of Para. In one fault there was found a very large piece of hard bony substance, about 1¼ in. in length, the part in the cable measuring something like 1 in. round. We were at loss to account for these faults at first, or to identify the tooth or tusk-like instrument with that of any fish we had seen, but when we got to Demerara we had no hesitation in attributing it to the teeth of the saw-fish, which exists plentifully in the water along the more northern portions of the Brazilian coast. Since last August another serious fault was localized about 130 miles from Para.



IMPROVED VELOCIPEDE.

IN the sketch, D is the driving-wheel, having two cranks on its axle, at right angles to each other, and W is the leader. The lever L, which is connected with the large wheel, has a slot S, cut in it, by which it oscillates on the pin P, and moves with the revolutions of the wheel.

This lever can be conveniently worked by the legs from the saddle S, and in the position represented where the lever shown is not producing much effect, the rider is pressing with full force on the other.

The steering and stopping can be arranged as in the ordinary machine, and thus we have a bycicle which will allow of the driving-wheel to be increased to any size compatible with lightness.—*English Mechanic.*

## LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MACCORD.

No. XXVI.

WE have given some illustrations of cases in which certain solids are cut by planes; and we hope that many of our readers have studied them to such purpose that they have already discovered the general principle upon which the process of determining these sections is based. This principle might have been mentioned and explained at once; but we purposely avoided doing so, for two reasons. One is, that there is a satisfaction in reasoning out a general principle for one's self, from a number of isolated examples, of which we did not wish to deprive any of our readers,—and not only that, but, as we have before remarked, knowledge thus gained is sure to be thorough, and more likely to be permanent than if acquired without an effort. Another is, that—supposing the principle not to be discovered, but to be stated by us—it will be more readily grasped, and the mode of applying it more thoroughly understood, as well as more obvious, by reason of the previous explanation of these examples.

We proceed now on this supposition, that some of our readers, not having formed the habit of generalizing, or of comparing such isolated problems with a view of detecting resemblances, have failed to catch the principle alluded to; and we will try to give them a hint which may be of future service in pointing out a mode of reasoning by which they might—and, if they had thought of it, probably would—have been able to frame a rule or general mode of operation applicable in not only the cases given, but all others of similar nature.

Referring to Figs. 193 and 212, in which we have the sections of the prism and the cylinder, by planes inclined to their axes, the reader will observe that the points in the lines of intersection are found by drawing on the surfaces of the solids certain lines which are cut by the planes. Each line is cut by the inclined plane in a point, which is clearly on the line of intersection of which we are in search; and the plane is so situated that we can find the point in which it cuts the line drawn on the surface. It need hardly be said that the plane might have been so inclined that we should not see it edgewise in either of the views of the solid in the position which we wish it to occupy. But we could always turn the solid and the plane together, so that the latter *should* be seen edgewise without altering the inclination of the plane to the axis of the solid, if it had an axis, which is the case in the examples given. By thus placing it, the construction is very much simplified, as we then see at once the distance from the base at which the plane cuts any one of the vertical lines drawn on the surface; and after we have thus found the line of intersection we may turn the solid back again, as in Fig. 214.

Now, comparing Figs. 207 and 225 with these two, we find substantially the same process employed. To be sure, the lines drawn on the surfaces are not vertical nor parallel; in the pyramid they are merely the edges formed by the intersection of the adjacent plane faces, and in the cone they are right lines drawn from any points of the base, assumed at pleasure; and in both cases they converge in the apex of the solid. Nevertheless, the line of intersection is determined substantially as before; that is, by the points in which the given plane cuts lines drawn on the surface under consideration. And it will readily be seen that no matter what may be the form of a surface or the position of a plane which cuts it, we shall be able to determine the outline of the section thus made, if we can tell where the plane cuts a series of lines drawn on the surface. In the instances given we have used the edges of the prism and the pyramid, and right lines drawn on the cylinder and the cone, merely because they are the simplest and most convenient lines; it would have made no difference in the result, nor would there have been any modification of the principle, had we made any other marks on the surfaces and not used the right lines at all: but, of course, it would be absurd to employ a complicated process when a simpler one would serve the purpose.

And the fact is, that in order to determine the form of such a section, we must know enough about it to be able to locate these auxiliary lines, and first to determine them,—that is to say, we must be able to draw lines whose forms we know; and also we must be able to find the points in which the plane cuts these lines.

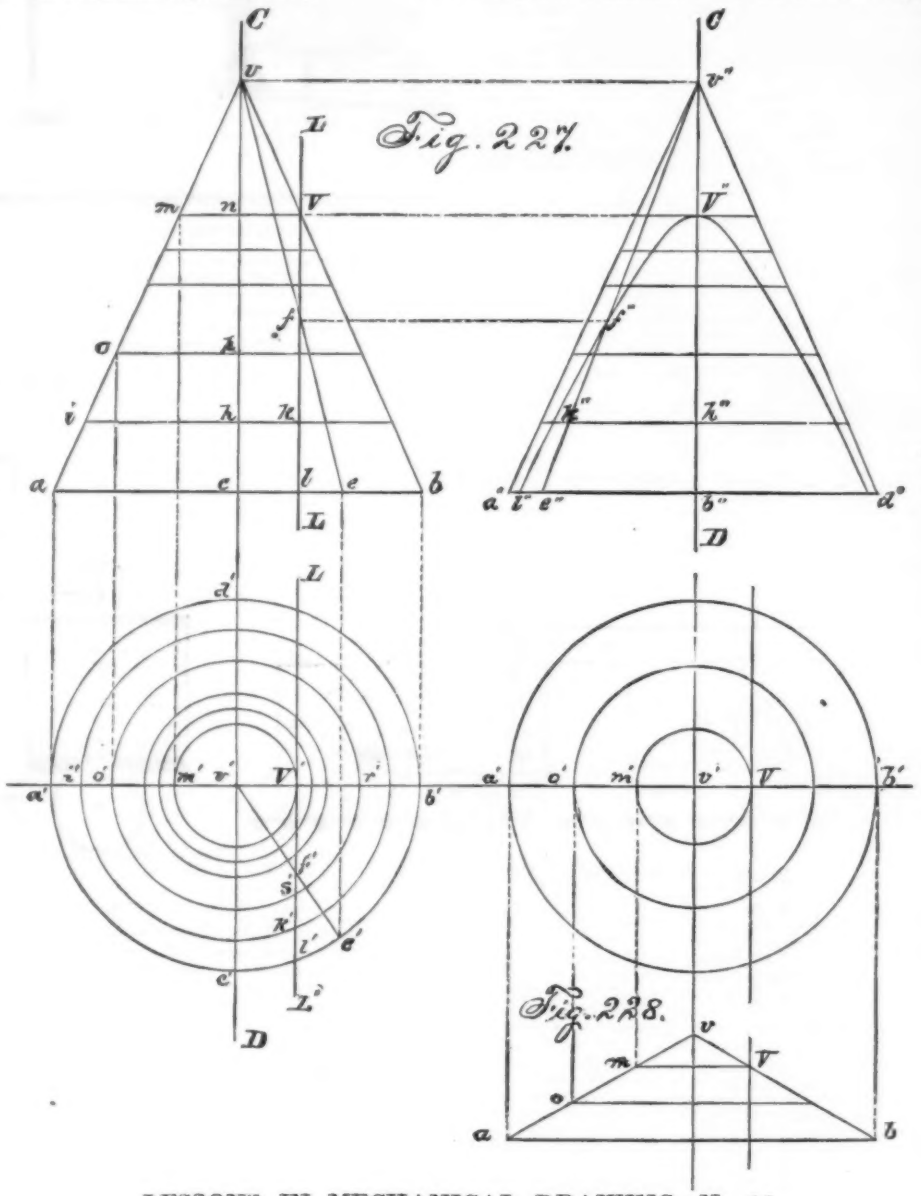
Now it will be seen that this principle, being so general in its nature, enables us not only, as above suggested, to solve the same problem in different ways by making use of different series of lines in determining the points of the section, but by the same means to test the accuracy of our work. We have already found, in the construction of the section of the cone by the inclined plane, the advantage of being able to use more than one method; and similar instances will frequently occur in future exercises.

It was remarked above that right lines were the simplest to work with, and were selected for that reason. But it does not follow that it is always best to select them; simple though they and their management may be, it will sometimes be found that a system of other lines will be either more convenient or more reliable in the results.

An illustration of this is given in Fig. 227, in which C D is the axis of a cone which is cut by the plane L L parallel to the axis. This axis being vertical, the plane is also vertical; we see it edgewise in the front view, and it is clear that because it is vertical we shall also see it edgewise in the top view, where it appears as the line L′ L″. Neither of these views, then, give any idea of the form of the section, which, however, will be seen in its true form and size if we construct a third view from the right-hand side. Now, we might do this in the method first spoken of,—that is, by drawing right lines from the vertex to the base, piercing the plane. For instance, $v\,e$ is such a line, which in the top view appears as $e'\,e'$, and is cut at the point marked $f$ in one view and $f''$ in the other. In the side view this point will be found at the same height above the plane of the base, and as far to the left of the axis as $f''$ is below $a'\,b'$. Or, we may set off $b''\,e''$ equal to $g'\,e'$, and drawing $v''\,e''$ the side view of the element $v\,e$, project $f$ horizontally across, in order to locate $f''$, which will be a point in the outline of the section in process of construction.

This process is, geometrically, all correct; but it is very evident that if the angle at the apex of the cone be acute, the intersections, though they are of right lines, will be also acute, and, as long ago pointed out, for that reason not practically definite or reliable. Under these circumstances a much more satisfactory mode of procedure is as follows: It will be at once noticed that in the top view the intersections of the circumference of the base by the line L′ L′ give two points in the required curve, and by setting off $b''\,l''$ equal to $V'\,l'$, we have the lowest one on the left of the axis in our new view; as it is obvious that the curve must be symmetrical about C″ D′, we may confine our attention to the drawing of the left-hand side altogether. Now, if we suppose the cone to be cut across by a horizontal plane, say through $h$, the section will be a circle whose radius is $h\,i$, or in the top view $v'\,i'$; this circle also is cut by L′ L′, giving $k'$ to correspond to $k$ above, so that by drawing the horizontal in the side view and setting off $h''\,k''$ equal to $V'\,k'$, we have a new point in the curve.

This process may be repeated as often as desirable, and any number of points in the section thus determined. But it will be observed, doubtless, by the careful student, that these determinations become less reliable as we approach the vertex of the cone. For, clearly V is the highest point of the curve, and if we draw a horizontal plane through it, the circle thus formed, whose radius is $n\,m$, or in the top view $v'\,m'$, will be tangent to L′ L′, as shown; and parallel planes a little below this one will give circles cutting L′ L′ very acutely. But he whose attention to the subject leads him to discover this objection, will be very likely also to see that in this particular region the reliability of the first method is greatest, so that by judicious combination of the two processes, such an one may be safely trusted to construct his curve with a reasonable degree of accuracy.




## LESSONS IN MECHANICAL DRAWING, No. 26.

If the base of the cone be very large in proportion to its altitude, making the angle at the vertex very obtuse, as in Fig. 228, the angles at the base will be acute, and it may be then objected that the intersections of the outlines by the horizontals, as at $o$, are also equally acute, thus vitiating the results of the very first step in this process by rendering the radii of the circles uncertain. But in this case $v\,V$, $v'\,V'$, certainly are definitely given; describing the circle in the top view, $m'$ is thus accurately fixed, and $m$ may be located by setting off $v\,m = v\,V$; then it will be observed that $a\,m$ and $a'\,m'$ are proportionately divided—that is to say, that if we bisect $a\,m$ at $o$, $a'\,m'$ will be also bisected by $o'$, the top view of $o$. Instead, then, of first drawing the horizontals and relying upon their intersections with $a\,v$ to fix the points in the front view, and thus the radii, we may divide $a'\,m'$ and $a\,m$ separately into the same number of equal parts by the method given in Fig. 33, thus obviating the objection referred to.

It may be stated that there is also another process for determining the direction of the curve near its vertex V″ by means of right lines to which it must be tangent; this will be explained at some future time, as it involves the drawing of planes tangent to the cone, which it would be premature to discuss at the present stage.

This matter of constructing sections of solids by planes is very important, because it is continually happening that the internal arrangement of mechanism can only be shown clearly by means of sectional views; consequently the student is earnestly advised to give close attention to the problems of this nature which are presented. The same may be said of the matter of developing those surfaces which are capable of being developed, which finds direct application in the laying out of sheet-metal. For instance, the development of the cylinder, cut by a plane at an angle of 45 degrees with the axis, amounts, in practice, to giving the form of a sheet of tin which, when "formed up" into a tube, shall be one branch of a "square elbow." It will be understood, then, that it is not so much the development of a complete cylinder or cone, as the determination of the developed form of some line on the surface, that is of practical interest and importance. The first, as we have seen, is simple enough—so, also, it may be said, is the latter—still, though this may be strictly true in so far as the abstract principle is concerned, cases arise from time to time which, in practice, are not so easy to execute accurately. So also with the converse operation of finding the form which will be assumed by a given line drawn on the developed surface, when the latter is wrapped up again into its original form.

We have heard of an ingenious practical solution of the first problem mentioned—that is, "to find the shape of a template for a square elbow"—which was effected in this wise: the operator took a tin tube of the given size, inclined it at an angle of 45 degrees, fixing it in that position in a tank, which he partially filled with water, and this, finding its level, its surface was the cutting plane; so, carefully and quickly removing and unrolling his tube, he cut off the wetted part. The ingenuity of the expedient is commendable; still it is hardly to be doubted that he who devised it would have been glad to say that it was not necessary for him to resort to it, but that he could "lay out" the template by geometrical methods, equally correct in principle and more reliable in practice.

In Fig. 229 we have shown the process of developing the cone of Fig. 227, and of finding the developed form of the section by the plane L L. The cone is here supposed to be cut along the left-hand element $a\,v$, of the front view; and were it not cut by the plane, the convex surface would assume the form of the sector F W G, which is determined as explained in the last lesson. A record of the process is kept by introducing the diagram of construction, as in Fig. 226, the arc G B F being drawn with radius W B equal to $a\,v$, the slant height, and the arc H B C with radius A B equal to that of the base of the cone $a'\,v'$ in the top view of Fig. 227. B C, an arc of 60 degrees, rectified on the tangent K B D, gives B D, whence we find B E, also equal to B C, and set it off three times on each side of B to determine G F. This base circle is cut by the plane at the point $l'$ in the top view alluded to; we then set off the arc B H equal to one half of $b'\,l'$; its rectification gives B K, whence we find B I equal to B H, and doubling this, we have B L equal to $b'\,l'$, thus locating L, the point in which the curve cuts the developed base. The vertex of the curve V is found at once by setting off W V equal to $v\,V$, of Fig. 227. Other points might be found by drawing elements of the cone, finding their intersections with the curve on the undeveloped surface, then determining the positions of these elements in the development, and finally marking off on these the actual distances of those intersections from the vertex, precisely as in Fig. 226. Were this method to be adopted, it is to be pointed out that labor would be saved by subdividing the arc $b'\,l'$ into a convenient number of equal parts, and drawing the elements through the points of division for the purpose of finding the development of the section; because, if that be done, the corresponding positions

of the elements in the development may be found by subdividing B L, of Fig. 229, into the same number of equal parts, and drawing radii from W to the points of division; whereas, if the elements be drawn at random, it will be necessary to rectify separately a number of arcs. Thus, it is obviously more convenient to make use of the element $v e$, of Fig. 227, if $b' s'$, in the top view, be an aliquot part of $b' l'$, than if it be not. This is mentioned here as a general principle, or suggestion of a means of saving time, which will be found of more use in subsequent examples than it is in this case. For the intersections of these elements by the curve on the cone before development are so acute as to render this process ineligible; and a better, though more tedious, method is to make use of points in the section located by the intersection of horizontal circles on the cone with the cutting plane.

For instance, the horizontal plane through $o$, Fig. 227, cuts the cone in a circle whose radius is $o p$, or in the top view, $o' e'$, and this circle will develop into the arc X N Y, of Fig. 229, whose radius is W N, equal to $v o$. With radius M N $= c' o'$, draw an arc tangent to X N Y at N, and set off on it N O equal to $r' s'$, of the top view of Fig. 227. Rectify this arc on the tangent, thus finding its length N P, from which, as before, determine N S — N P — N O $= r' s'$, which will give S a point on the developed curve. Were the arc $r' s'$ greater than 60°, we might bisect it, and proceed as in determining B L on the development of the base circle; and by proceeding in a similar manner, we may find as many points as are

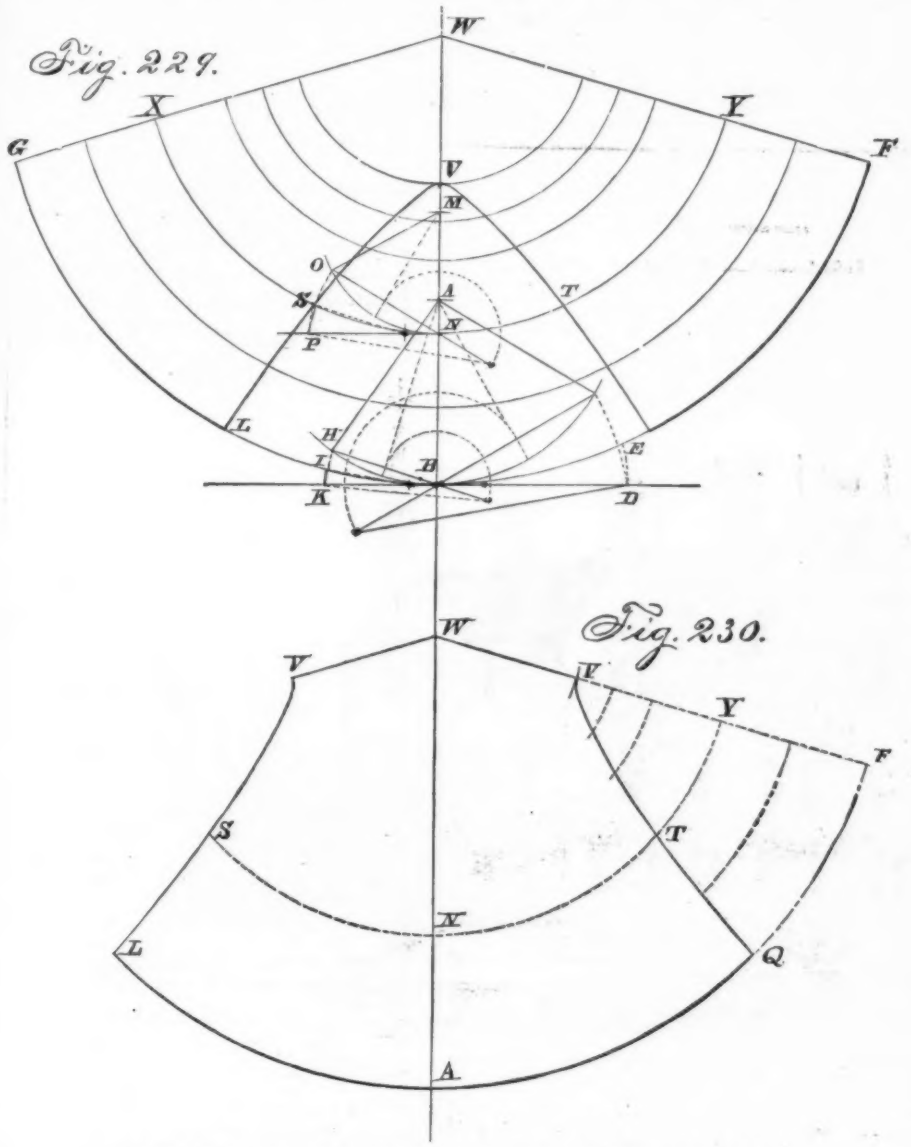



Fig. 229.




Fig. 230.

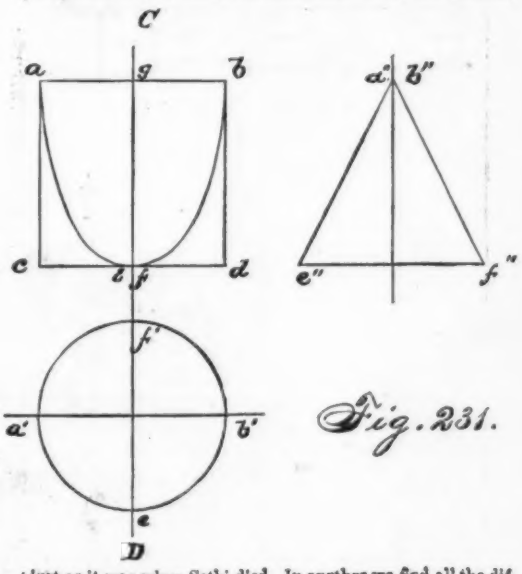



Fig. 231.

out the single piece bounded by the continuous curve in the former, which again illustrates a kind of forethought and exercise of judgment, which is a part of the draughtsman's duty, if he be engaged in practical work. He is expected, and reasonably too, not merely to make drawings accurately and well, but to solve the problems which arise in the most advantageous manner, if there be any room for choice. And in problems of this nature there generally is; because, as in the case above discussed, the actual outlines and dimensions of the developed surface may be largely dependent on the position of the line, by which it is cut before development, thus directly affecting the economy of material, which may "cut to waste" much more in one form than in another; and the other consideration of the length of the seams or joints to be made in "forming up" the sheet metal after it is cut out, is by no means an unimportant one.

Fig. 231 is introduced as a striking instance of the necessity, under some circumstances, of giving three projections of an object, in order fully to define it; and it may serve also to combine amusement with practice in the construction of sections. The object represented is of very simple form, and may be familiar to our readers as the solution of the puzzle, "What is the form of the solid which will pass through a round hole, a square hole, and a triangular hole, and exactly fit each one?" This apparent impossibility is really very easily accomplished, as the figure shows. Let C D be the axis of a cylinder whose altitude, $a c$, is equal to its diameter. On the upper base draw a diameter, $a b$, or $a' b'$, in the top view, and on the lower base another, $e f$, whose projection, $e' f'$, in this last view is at right angles to $a' b'$. The cylinder is then cut by two oblique planes, which intersect in the line $a b$, one passing through $e$, the other through $f$, as more distinctly shown in the third or side view, in which the outline of the solid is an equilateral triangle. The curve $a e b$, seen in the front view, is, we need hardly say, a semi-ellipse, of which $a b$ is the minor axis, $g e$ being the semi major axis of the ellipse seen in that view. If the actual form of the section be required, it may be at once constructed, being also a semi-ellipse, of which $a b$ is the minor axis, the semi-major axis of that ellipse being $a'' e''$ of the side view.

## LESSONS IN MECHANICAL DRAWING, No. 26.

necessary. The other circles in the diagram are the developments of other horizontal sections of the cone, by which the curve L S V T Q was determined.

If, then, we cut out a sector G W F, and out of that cut a piece of the form of this curve, we may, by rolling up the sheet into a cone, or rather into what is left of one, make a model of the solid, after being cut by the plane, which will be rendered complete by adding a piece of the form of the curve in the side view of Fig. 227, and the base, which is merely that part of the circle on the left of L' L' in the top view.

But it is observed that in practice it would be better to cut the cone somewhere else than along the line $a v$; we selected that line because the form of the developed curve is thus better shown. But it would clearly be more judicious, in making such a model, to cut it along the opposite element $b v$. It is at once seen that this will give a shorter seam; and a glance at Fig. 230 will show another practical advantage. The development is there made by supposing the cone be laid on its side, so that $a v$ shall coincide with A W, and then unrolled to the right and left. Under these circumstances the edges W V will, when the sheet is wrapped up again into the cone, meet in the element $b v$; we have then to set off F Q equal to B Q, of Fig. 229; Y T equal to N T, and so on, thus determining one branch of the curve, the other one being similar to it, and laid off from the opposite edge of the sector. A comparison of this figure with the preceding one will show that the last selection is much more economical, since, although the actual area of the material used is of course the same in both cases, a smaller piece will serve the purpose, it being unnecessary to cut out the whole sector to begin with. Besides, it is practically easier to cut out the two branches of the curve, if separated, as in the latter instance, than it would be to cut

## THE HISTORY OF ART.

SIR JOHN LUBBOCK recently distributed the prizes to the students of the Maidstone School of Art, and subsequently made the following remarks:

The history of art is one of the most important keys to the true history of man—the history, not of wars and conquests, but of peaceful development. It is really the true history of the human race. The earliest drawings we possess are scratched upon bone or stone, reminding us of the first sketches of Giotto, who, when a child some ten or twelve years old, was found by Cimabue drawing sheep on a piece of smooth slate with a sharply pointed stone; and in the same way the most ancient men of whom we have any certain knowledge, sketched outlines of the mammoth, of reindeer, bears, and other animals on bone and stone, probably with a sharp-pointed flint. These drawings, moreover, are of special interest, because the skill with which they are executed seems the more remarkable if we recollect that some existing savages are said to be unable to recognize delineations of natural objects when they are put before them. The ancient drawings, moreover, are of special interest, because I think we may fairly hope that just as the Esquimaux drawings of the present day, which, by the way, singularly resemble those found in the caves of Western Europe, represent and would give us a fair idea of their daily life and avocations; and we may hope also that they will clear up much of the mystery of the past, on which even now they have thrown a bright thread of light. It is curious that, while in the Stone Age we have spirited representations of animal life, the ornamentation of the later Bronze Age, so far as it is known to us, is almost confined to lines, straight, curved, and especially spiral. Whether this difference indicates an ethnological distinction we are perhaps hardly yet in a condition to predicate with confidence. That absence of representations of animal form under certain circumstances by no means necessarily implies any want of power, we may see clearly from the fact that while striking representations of every-day life illustrate the Egyptian tombs of one period, as for instance that of Ti at Takkarah, and mystical allegories, those of the kings at Bab-el-Moulak, opposite Karnac, the minor passages and chambers of the earlier dynasties, as for instance in the great pyramids, are left quite plain; while, on the other hand, the high pitch to which art had even then attained is shown by the statue of Cephren in the Boulak museum, certainly one of the most remarkable which the world has yet produced. The tombs of Bab-el-Moulak teach us another curious lesson. Among all the interesting wonders of Egypt few things perhaps are more striking than the tomb of Sethi I. This king is said to have connected the Red Sea with the Nile by a canal. He was the predecessor of Rameses the Great, who again was succeeded by Menepthah—the Pharaoh of the Exodus. In excavating these rock-cut tombs, the first thing was of course to form the chambers, which were cut out one by one; then the walls were smoothed, after that the figures were put in roughly, then came a draughtsman, who drew them carefully in black chalk, then the master, who corrected with a red pencil any fault in drawing—I do not know if this is the mode followed in the art schools of the present day—and lastly the designs were carefully painted in. Now, in Sethi's tomb we see every stage of this process. The innermost room is quite rough and unfinished—being now probably just as it was when Sethi died. In another we find all the different stages of the drawing. In one part of the walls, even in the present day, you can see where the figures are merely indicated, the head for instance being a circle, the hands without fingers, and so on. Then in another you have the outlines carefully filled in by the pupils, and still showing here and there corrections made by the master hand. And lastly the complete work. Again, here is another illustration of the important light which art throws upon history. The students of Central American history, in seeking for the source of that remarkable civilization, owe much of what little light they have been able to obtain from the remains of the art of the period, in which some have thought themselves able to trace indications of Chinese, others even of Egyptian influence. It would be easy; if time permitted, to bring together many illustrations of the light which art throws on history; still more important, however, is the general influence which it exercises on the character of man.

### THE EXCUSES OF IDLENESS.

Now, we often hear people say that they have not time enough to give attention to art, but this is too often rather an excuse of idleness than any indication of industry. At any rate, even if true in individual application (I have no doubt it is true in some cases—I might claim to be a case in which it is), as a general rule people—or I will at any rate say many people—are sorely in need of interesting occupation. One day last year, in walking from the city to the House of Commons, I found the Thames embankment crowded with men and women, who had come to look over the wall because it was expected that the tide would rise against the stones a few inches higher than had ever been known before. This showed that they had not much of interest to do. One characteristic of the present age is a certain restlessness and craving for excitement. Nothing, however, is more calming and soothing than art. One great master, indeed, has said that it is impossible to draw unless you are in peace. In words which no doubt are well known to you, he says: "Painting can only be done in calm of mind. That peace must be rendered habitual, as the waters settle themselves into clearness as well as quietness. You can no more filter your mind into purity than you can compress it into calmness. You must keep it pure if you would have it pure; and throw no stones into it if you would have it quiet." But, however this may be—whether calm be indispensable to true art or not—no one can deny that the contemplation of beauty tends to soothe the mind, and distract it alike from petty troubles and deeper sorrows. So much has public taste improved of late years that there is now really no reason at all why we should, any of us, even the poorest, have any thing ugly in our houses. Beauty costs nothing. An ugly paint costs no less than a good one; a clumsy glass, or jug,

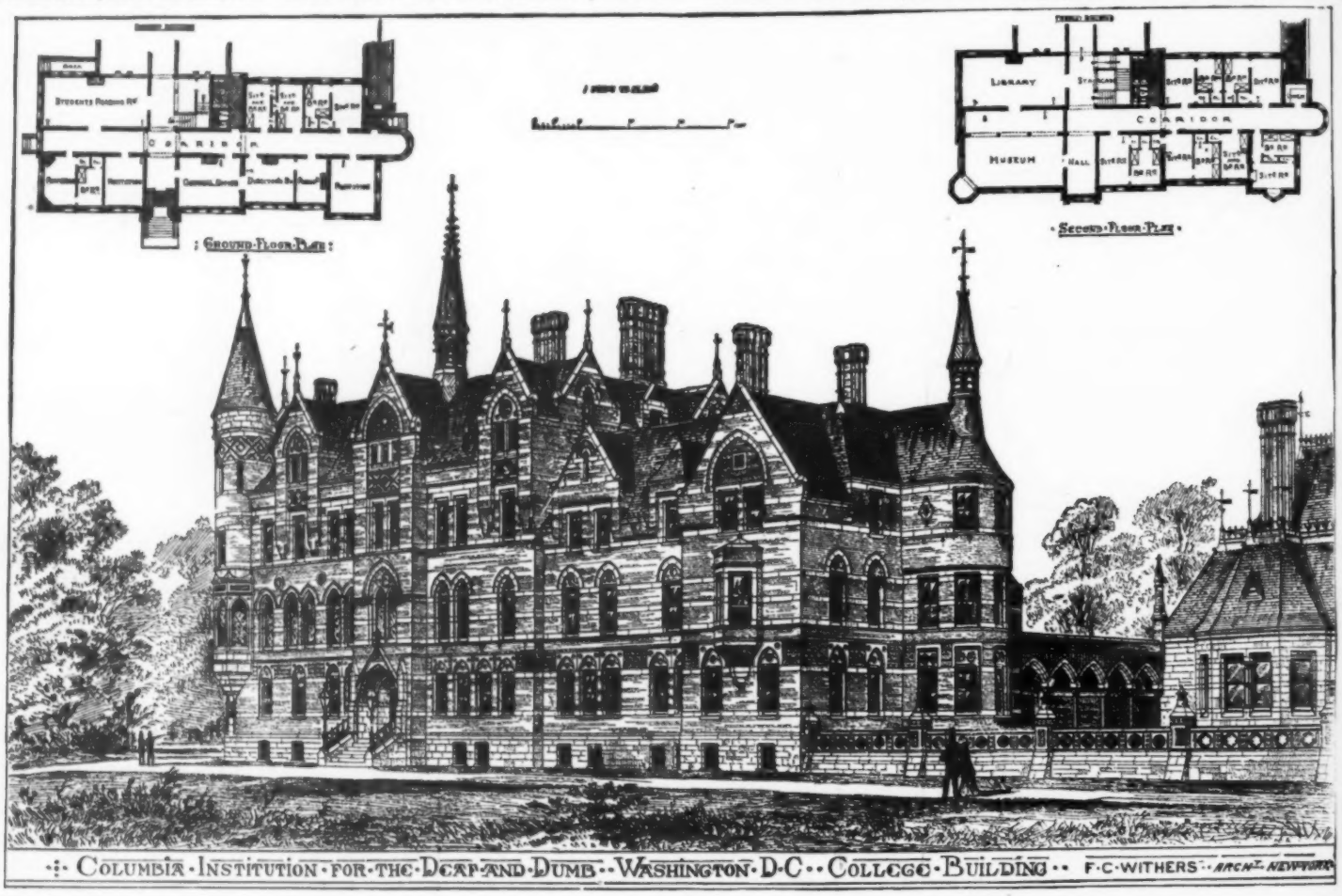
or cup, or ugly table-cover, is as expensive as a more graceful form and more beautiful design—nay, costs less really to produce, because the one is a product of mere slavish drudgery, and the other is a triumph of loving art, which can but raise and ennoble the artist who designed them. Now, while I wish to congratulate most sincerely those to whom I have just had the pleasure of presenting prizes, I am sure that I need not impress on those who have not yet been so fortunate, that they should on no account be discouraged.

PERSEVERANCE CONQUERS.

Sir Joshua Reynolds, in his discourses to the Royal Academy students, was never tired of impressing on them the necessity of continuous, patient, and devoted labor. In almost every one of the fourteen discourses which he delivered as President of the Royal Academy, he is most careful to impress this great truth on the attention of his auditors. Indeed, every page in the lives of the most eminent painters shows us that no part of their lives was ever spent in idleness or dissipation. Even of Raphael himself—whom many think, perhaps justly, the greatest of them all—and Michael Angelo, perhaps the second, we were assured did not possess their art from nature, but from long study. "To be convinced," says Sir Joshua, "with what persevering assiduity the most illustrious and highly gifted of them pursued their studies, we need only reflect on their method of proceeding in their most celebrated works. When they conceived a subject they first made a variety of sketches; then a finished drawing of the whole; after that a more correct drawing of every separate part—heads, hands, feet, and pieces of drapery; they then painted the picture, and after all retouched it from the life. The pictures thus wrought with such pains now appear like the effect of enchantment, and as if some mighty genius had struck them off at a blow." One caution, however, perhaps is necessary. The industry which Sir Joshua so persistently recommends is not merely the industry of the hands, but of the mind also. In the words of Dr. Young, "He that imitates the 'Iliad' is not imitating Homer," nature must be studied as well as copied. It is indeed by no means so easy as is generally supposed to see what is before us. The merely mechanical power of copying does not make a man an artist. Ruskin, who is no less a master of the English language than he is the great guide in all matters of art, tells us this: "He who has learnt," he says, "what is commonly considered the whole art of painting—that is, the art of representing any natural object faithfully—has as yet only learnt the language by which his thoughts are to be expressed. He has done just as much toward being that which we ought to respect as a great painter, as a man who has learned how to express himself grammatically and melodiously has toward being a great poet. The language is, indeed, more difficult of acquirement in the one case than in the other, and possesses more power of delighting the sense, while it speaks to the intellect; but it is, nevertheless, nothing more than language, and all those excellencies which are peculiar to the painter, as such, are merely what rhythm, melody, precision, and force are in the words of the orator and the poet—necessary to their greatness, but not tests of their greatness." Nor does high art necessarily accompany even the combination of judicious selection and the possession of manual skill. Something more than this is required, or the result, even with these advantages, will, after all, be but a melancholy failure; as when Robespierre, at the so called feast of the Supreme Being on the 20th Prairial (8th June, 1794), intending to burn down the symbolical statue of Atheism with its attendant vices, accidentally set fire to that of Wisdom instead. The object must be considered as well as the subject. "The difference"—and here I will conclude with one more quotation from Ruskin—"between great and mean art lies, not in definable methods of handling, or styles of representation, or choices of subjects, but wholly in the nobleness of the end to which the effort of the painter is addressed. It does not matter whether he paint the petal of a rose or the chasms of a precipice, so that love and admiration attend him as he labors, and wait forever upon his work. It does not matter whether he toil for months upon a few inches of his canvas, or cover a palace front with color in a day, so that it be a solemn purpose that has filled his heart with patience or urged his hand to haste. And it does not matter whether he seeks for his subjects among peasants or nobles, among the heroic or the simple, in courts or in fields, so only that he behold all things with a thirst for beauty, and a hatred of meanness and vice." And with these words I will conclude the short address I have ventured to make to you this evening. Once more I must congratulate those who have carried away prizes. I would impress upon all the advice of the greatest English painter, that merit can only be arrived at by great labor and continued exertion. Also the noble words of Mr. Ruskin which I have just read: In whatever department of art you may toil, endeavor to do every thing in a thirst for beauty and a hatred of meanness and vice.

## COLUMBIA INSTITUTION FOR THE DEAF AND DUMB, WASHINGTON, D.C.

THIS building, of which we give illustrations, is now in course of erection for the United States Government, at Washington, D.C. The ground floor is arranged for the offices in connection with the institution, and for the reading-rooms, recitation-rooms, etc., for the students. The second floor contains a library and museum; and, in the third floor, over the library, a room for a literary society is provided. The remainder of the building is intended for dormitories and living-rooms; some of the rooms being for two students, with a sitting-room and bedroom adjoining, and others for single students, with a sitting-room and bedroom combined. The building will be connected by an open corridor with the main central building, containing the chapel, refectories, etc., which was erected some years since. The walls are built hollow, faced with Baltimore pressed brick, with dressings of Ohio stone. The passages and staircase are to be fireproof; and all the partitions that are not of brick are to be constructed of fireproof blocks. The whole is to be heated by steam and thoroughly ventilated. The work is being executed from the designs of the architect, Mr. Frederick P. Withers, of New York.—*Building News.*




## HOUSE DRAINS IN OLD LONDON.

THE *Lancet* says: We believe there is no exaggeration in saying that the house drainage of nearly two thirds of houses in the older London parishes is defective. The drains originally constructed of brick, through age and the undermining activity of rats, have become extensively pervious, and the domestic sewage passes out freely into the basements, and but a small portion reaches the sewers.

## THE PAVEMENT OF MILAN.

AT this moment, when the "battle of the pavements" is still engaging public attention and dividing and puzzling the members of vestries and local Boards, a few words to describe the excellent system adopted at Milan may be welcome to all who are interested in this important question. On each side of the streets there are two lines of flag-stones, sufficiently broad to bear the wheels of every sort of vehicle. Between these parallel lines the pavement consists of small unequal stones, on which the horses may step with security and without the least fear of slipping. On the other hand, the wheels of the carriage revolve easily, smoothly, and without the slightest noise, on the even surface of the flag-stones. Of course, these slab stones and the smaller pavement are kept on the same level, so that a carriage may be driven off the line, to turn or outstep another vehicle in front, without the least impediment. Practically, and so far as we are aware, this system has given rise to no inconvenience, and combines the rival advantages of pavement and asphalte; but we should recommend visitors to the Corso at Milan to judge for themselves.—*The Builder.*

## STRENGTH OF MORTAR AND CEMENT.

IT is not quite understood what effects the admixture of sand has upon the tenacity or strength of cement, though many bricklayers assert that equal parts of sand and cement have nearly the strength of the neat material. This assumption, according to some, is not based on experiment, which shows that the addition of sand diminishes the tenacity of the cement in a quadruple ratio, and it is found equal parts of sand and cement mixed together have only the fourth part of the strength of pure cement. It is evident, therefore, that economy is the only advantage gained. When used pure, after 20 days' exposure to the air, the resistance to rupture of pure cement is about 54 lbs. per square inch; according to one authority, when the proportion of sand and cement are equal it falls to 27 lbs., and when the proportion is half to one of cement the resistance is 37 lbs. These results are somewhat different, but they may arise from differences of cement and modes of investigation. Rondelet observes that the resistance to crushing is three times the resistance to traction. The only advantage of using sand with cement is that when it is exposed to the air, as in the face of a wall, it is less liable to crack and shrinkage from unequal drying.

In all cases where this exposure is not necessitated, and where great strength is required, pure cement is the best; and it would seem that the most desirable mode of using natural cements is to employ them without sand in hydraulic works, or wherever great strength is the desideratum. For works exposed to dampness 2 to 3 of cement is a good mixture, and this is a good proportion for architectural purposes. For face work 3 of sand to 2 of cement may be employed. The following data from Rondelet, given by Rankine, may be found useful; the mixtures being one year and a half old.

| | Crushing force in lbs. per sq. inch. |
|---|---|
| Mortar of lime and river sand | 440 |
| Beaten | 600 |
| Mortar of lime and pit sand | 580 |
| Beaten | 800 |
| Hydraulic mortar of lime and pounded tiles. | 680 |
| Beaten | 930 |
| Béton or concrete of mortar and broken flints. | 420 |

Sixteen years after mixture the increase of strength is found to be for common mortar one eighth, and for hydraulic mortar one fourth. For tenacity, hydraulic lime, according to Vicat, one year after mixture, attains from 170 lbs. per sq. inch in the best to 100 lbs. in the ordinary kind, and mortar 50 lbs. to the sq. inch for the best, and 20 lbs. for the worst.—*Building News.*

## THE STANDISH MONUMENT.

THE monument in process of construction on Captain's Hill, Duxbury, Mass., in honor of the Pilgrim captain, has reached the height of fifty-nine feet. The work is massive, and can already be seen twenty miles away. Pilots along the coast of Plymouth Bay have already entered it on their charts as a guide that will be likely to be permanent. The size of the base is thirty feet, and it will be fifteen feet in diameter at the top when finished. The solid outside wall, laid wholly in the best cement, is two and one half feet thick.